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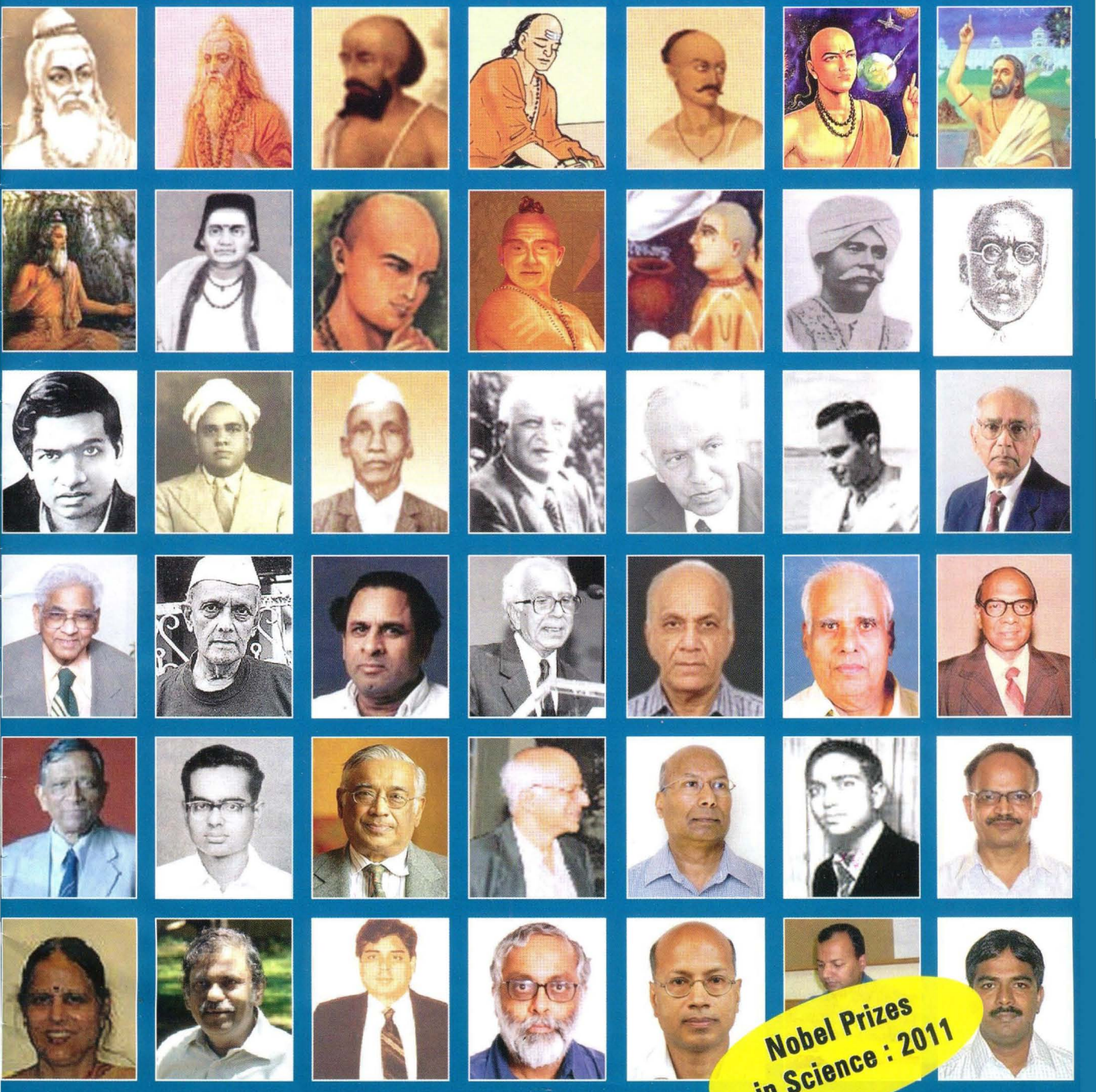
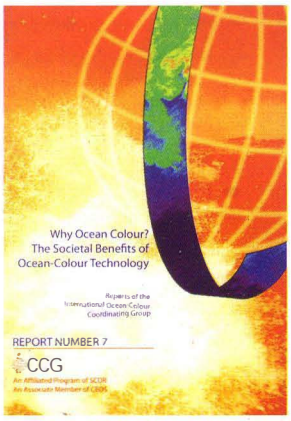


Nobel Prizes in Science : 2011

A Brief Overview of India's Contributions in Mathematics

BOOK OF THE MONTH

Why Ocean Colour? The Societal Benefits of Ocean-Colour Technology



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Author	:	Trevor Platt, Nicholas Hoepffner, Venetia Stuart and Christopher Brown (Eds.)
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The Earth system lies in a delicate balance set by a suite of forces operating in and between the land, ocean, atmosphere and cryosphere. Although the oceans play a critical role in our climate, they remain the least explored of the Earth's environments. Understanding the ecology, biogeochemistry and hazards of our oceans is varying and changing climate is critical to sustaining Earth as a habitable planet.

The ecosystem of the ocean differs from that on the land in that the green plants in the ocean are predominantly microscopic. These are the community of single-celled algae collectively known as phytoplankton. The integrity of the marine ecosystem is maintained through the constant input of energy from the sun. Only the visible part of the solar spectrum can be captured by the ecosystem for photosynthesis, and the interface that couples it to the Sun is provided by the pigment molecules (principally chlorophyll) contained in phytoplankton. As they absorb and scatter light from the Sun, phytoplankton exert a profound influence on the submarine light field, including the flux upwards across the water surface. The intensity and wavelength of this flux can be measured by radiometers carried on space craft, thus providing the basis for visible spectral radiometry, also known as ocean-colour radiometry (OCR) or simply ocean colour.

OCR by earth-orbiting spacecraft has already been conducted some 30 years back. The proof of concept that chlorophyll concentration could be observed all over the oceans on synoptic scales, with useful accuracy and precision, has been demonstrated beyond all doubt. The results of ocean colour have revolutionized the field of biological oceanography, and have made important contributions to biogeochemistry, to physical oceanography, to ocean-system modeling, to fisheries oceanography and to coastal management. By the nature of the technology, OCR is global in scope, as are many of the outstanding issues of the day, such as those related to climate change. Moreover, ocean colour is our window into the marine ecosystem on these scale.

In the present Monograph, the many applications of data acquired by remote sensing of ocean colour, in both the research and operational arena are illustrated. The chapters of the book are:

1. Ocean-Colour Radiometry and the Public
2. Ocean-Colour Data – An Aid to Modelling
3. Ocean-Colour Radiometry and Ocean Physics
4. Biogeochemical Cycles
5. Ocean-Colour Radiometry and Fisheries
6. Ocean-Colour Radiometry and Water Quality
7. A Window on the State of the Marine Ecosystem
8. Hazards: Natural and Man-Made
9. Ocean-Colour Climate Change
10. Future Perspectives

The Monograph exactly demonstrates the benefits to society of investment in ocean colour technology. The benefits are many and varied, and taken together make a very impressive case for making ocean colour a key requirement in earth observation as a societal imperative.

Dr. A.R.S. Menon
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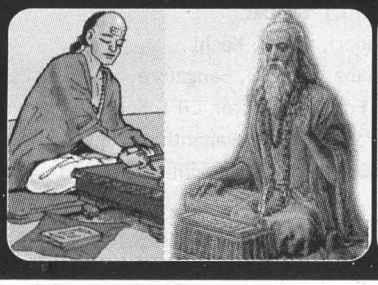

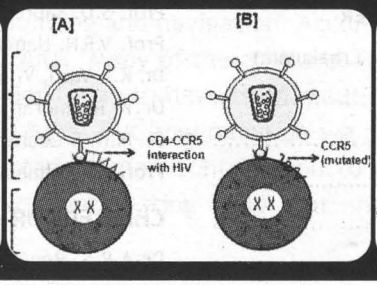

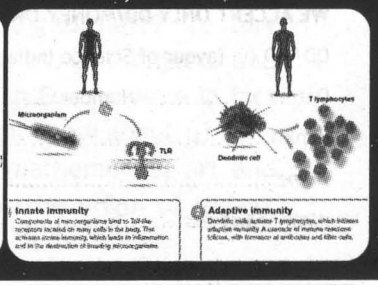

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Editorial

Mathematics, science and technology of ancient India covered many major branches of human knowledge and activities, including physics, astronomy, metallurgy, medical science and surgery, fine arts, civil engineering and architecture, shipbuilding and navigation. According to the 19th century British historian Grant Duff, "Many of the advances in the mathematics and sciences that
made in India centuries ago." But how much do we all know about it? Such investigation to understand Indian contribution to mathematics, art and architecture, reveals very interesting facts that are the origin of today's modern world.

It is without doubt that mathematics today owes a huge debt to the outstanding contributions made by Indian mathematicians over many hundreds of years. What is quite surprising is that there has been a reluctance to recognize this and one has to conclude that many famous historians of mathematics found what they expected to find, or perhaps even what they hoped to find, rather than to realize what was so clear in front of them.

Indian mathematics emerged in the Indian subcontinent from 1200 BCE until the end of the 18th century. In the classical period of Indian mathematics (400 AD to 1200AD), important contributions were made by scholars like Aryabhata, Brahmagupta, and Bhaskara II. The decimal number system in use today was first recorded in Indian mathematics. Indian mathematicians made early contributions to the study of the concept of zero as a number, negative numbers, arithmetic, and algebra. In addition, trigonometry was further advanced in India, and, in particular, the modern definitions of sine and cosine were developed here. These mathematical concepts were transmitted to the Middle East, China, and Europe and led to further developments that now form the foundations of many areas of mathematics.

The lead article in this issue of Science India is "A brief overview of India's contributions in Mathematics" by two students from National Institute of Technology, Calicut.

World AIDS Day falls on 1 December. This issue contains a special article on "Racial discrimination by HIV"

Team Science India

A BRIEF OVERVIEW OF INDIA'S CONTRIBUTIONS IN MATHEMATICS

Part - 1

K. Gopika and K.C. Bevita

Introduction

Mathematics has long been considered an invention of European scholars, as a result of which the contributions of non-European countries have been severely neglected in histories of mathematics. Worse still, many key mathematical developments have been wrongly attributed to scholars of European origin. This has led to the so-called Eurocentrism.

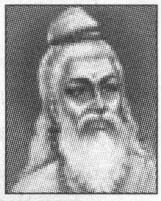
The neglect of non-European mathematics is no more apparent than when studying the contributions of India. Contrary to Euroscentric belief, scholars from India, over a period of some 4500 years, contributed to some of the greatest mathematical achievements in the history of the subject. Mathematics has played a significant role in the development of Indian culture. It spans from the Indus valley civilization and the Vedas to Modern times.

The prominent mathematicians can be classified chronologically as:

- Vedic period mathematicians
- Classical period mathematicians
- Medieval to Mughal period mathematicians
- Mathematicians born in 1800s
- Mathematicians born in 1900s

Vedic period mathematicians

Yajnavalkya

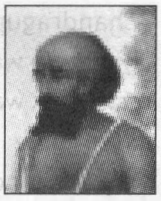


Yajnavalkya of Mithila (modern day Janakpur in Dhanusa district of Nepal) was a legendary sage of Vedic India, credited with the authorship of the Shatapatha Brahmana which contains calculations related to altar construction. He lived sometime in 9th-8th century BCE.

Baudhâyana

Baudhâyana was an Indian mathematician, who was most likely also a priest who lived in about 8th century BCE. He is noted as the author of the earliest *Sulbasûtra* – appendices to the Vedas giving rules for the construction of altars—called the *Baudhâyana Sulbasûtra*, which contained several important mathematical results. He is accredited with calculating the value of pi to certain degree of precision, and with discovering what is now known as the Pythagorean Theorem.

Apastamba



Apastamba lived in around 5th century BCE. He was a scholar and author of the 'Kalpa-sutras', a text on geometry. His Kalpa-sutra is divided into 30 chapters. While the first 29 chapters deal with rituals, the 30th contains information on geometry. One of the most notable facts deliniated by Apastamba is an approximation of the square root of 2. It must be noted that like all the other Sulba-sutras (vedic geometrical texts), it is not known how much of the mathematical development therein is original and how much is merely a transcription of existing knowledge.

Panini

Panini was born in Shalatula, a town near to Attock on the Indus river banks in present day Pakistan. The dates given for Panini are pure guesses. Experts give dates in the 4th, 5th, 6th and 7th century BC and there is also no agreement among historians about the extent of work which he undertook. What is in little doubt is that, given the period in which he worked, he is one of the most innovative people in the whole development of knowledge. Panini's great accomplishment was his study of the Sanskrit language, especially in his text *Ashtadhyayi*. Although this work might be considered as the very first study of linguistics or grammar, it used a non-obvious elegance that would not be equalled in the West until the 20th century. Linguistics may seem an unlikely qualification for a "great mathematician," but language theory is a field of mathematics. The works of eminent 20th century linguists and computer scientists like Chomsky, Backus, Post and Church are seen to resemble Panini's work 24 centuries earlier. Panini's systematic study of Sanskrit may have inspired the development of Indian science and algebra. Panini has been called "the Indian Euclid" since the rigor of his grammar is comparable to Euclid's geometry.

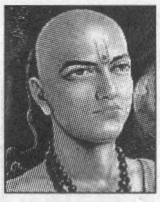
Kâtyâyana

Katyayana was a Sanskrit Grammarian and mathematician who lived in North India during the 2nd century BCE. Apart from his 'Varttika', an elaboration on Panini's grammar, he also composed one of the later Sulba-sutras, a series of nine texts on the geometry dealing with rectangles, right-sided triangles, rhombuses, etc.

Classical period mathematicians

The Post-Vedic Sanskrit to Pala period mathematicians (5th c. CE to 11th c. CE)

Aryabhata



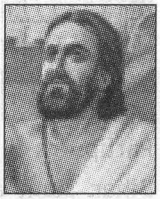
Aryabhata, also known as Aryabhata I (476-550 CE), one of the world's greatest mathematician-astronomer, was supposedly born in Patliputra in Magadha, modern Patna in Bihar. Many are of the view that he was born in south India probably Kerala and lived in Magadha at the time of the Gupta

rulers. However, there exists no documentation to ascertain his exact birthplace. Recently, based on certain astronomical calculations Chandra Hari attributed Aryabhata's birth place as Chamravattam near Trichur, Kerala.

His most famous works are the *Âryabhatîya* (499 CE, when he was 23 years old) and the *Arya-siddhanta*. Of these two texts on vedic astronomy, only the *Âryabhatîya* survives.

In addition he gave a unique method of representing large numbers by word forms. He systematized all the knowledge of astronomy and mathematics prior to him. The first one in Indian mathematics to give the formula for the area of a triangle was Aryabhata. The several results on triangles and circles and on progressions, algorithm for finding cube roots, approximation of π, all these give him a unique position in the development of mathematics. Aryabhata ushered in a Renaissance in Indian Mathematics and Astronomy, which resulted in a remarkable flourishing of science and technology in India. Aryabhata, for the first time, secularised mathematics and astronomy in India and established these as intellectual disciplines in their own right.

Varahamihira



Astrologer, astronomer and mathematician, Mihira or Daivajna Mihira, became famous as Varahamihira (499-587 CE). He was amongst the Navarathnas (nine jewels) in the court of King Vikramaditya (Chandragupta II - Gupta dynasty) of Ujjain. He was an Indian astrologer whose main work was a treatise on mathematical astronomy Panchasiddhantika which summarised earlier astronomical treatises. He discovered a version of Pascal's triangle and worked on magic squares.

Brahmagupta

Brahmagupta (598-668 CE) was an Indian mathematician and astronomer who wrote many important works on mathematics and astronomy. He is often referred to as Bhillamalacharya, that is, the teacher from Bhillamala (modern Bhinmal in Rajasthan). Brahmagupta was the first to use zero as a number. He gave rules to compute with zero. Contrary to popular opinion, negative numbers did not appear first in Brahmasputa Siddhanta. Negative numbers appear for the first time in history in the Nine Chapters on the Mathematical Art (Jiu zhang suan-shu) around 200 BC.

Brahmagupta's most famous work is his Brâhmasphutasiddhânta (Correctly Established Doctrine of Brahma), written in 628 CE in Bhinmal. It is composed in elliptic verse, as was common practice in Indian mathematics, and consequently has a poetic ring to it. Its 25 chapters contain several unprecedented mathematical results.

He formulated the rule of three and proposed rules for the solution of quadratic and simultaneous equations. He

gave the formula for the area of a cyclic quadrilateral as $\sqrt{(s-a)(s-b)(s-c)(s-d)}$ where s is the semi perimeter. He was the first mathematician to treat algebra and arithmetics as two different branches of mathematics. He gave the solution of the indeterminate equation $Nx^2+1 = y^2$. He is also the founder of the branch of higher mathematics known as "Numerical Analysis".

Bhaskara-I

Bhaskara-I was an Indian mathematician of the 7th century, who probably lived between c.600 and c.680. He was most likely the first to use a circle for the zero in the Hindu-Arabic decimal system, and while commenting on Aryabhata's work, he evaluated an extraordinary rational approximation of the sine function. There is very little information about Bhaskara's life. He is said to be born near Saurashtra in Gujarat and died in Ashmaka. He was educated in astronomy by his father. He is considered to be a follower of Aryabhata I and one of the most renowned scholars of Aryabhata's astronomical school. Bhaskara I wrote two treatises, the Mahabhaskariya and the Laghubhaskariya. He also wrote commentaries on the work of Aryabhata I titled as Aryabhatiyabhasya. The Mahabhaskariya comprises of eight chapters dealing with mathematical astronomy.

Some of the contributions of Bhaskara I to mathematics are: numbers and symbolism, the categorization of mathematics, the names and solution of the first degree equations, quadratic equations, cubic equations and equations which have more than one unknown value, symbolic algebra, the algorithm method to solve linear indeterminate equations which was later suggested by Euclid, and formulated certain tables for solving equations that occurred in astronomy.

Mahavira

Mahavira (800-870 CE) was an Indian Jain mathematician from Gulbarga, Karnataka who asserted that the square root of a negative number did not exist. He gave the sum of a series whose terms are squares of an arithmetical progression and empirical rules for area and perimeter of an ellipse. He was patronised by the great Rashtrakuta king Amoghavarsha. Mahavira was the author of 'Ganit Saar Sangraha'. He separated Astrology from Mathematics. He expounded on the same subjects on which Aryabhata and Brahmagupta contended, but he expressed them more clearly. He is highly respected among Indian Mathematicians, because of his establishment of terminology for concepts such as equilateral and isosceles triangle; rhombus; circle and semicircle. Mahavira's eminence spread in all South India and his books proved inspirational to other Mathematicians in South India. It was translated into Telugu language by Pavuluri Mallana as Saar Sangraha Ganitam.

Govindasvami

Govindasvami (800-860 CE) was an Indian mathematical astronomer whose

most famous treatise wa
on the Mahabhaskariya of Bhaskara I. Govindasvami wrote the Bhasya in about 830CE which was a commentary on the Mahabhaskariya. In Govindasvami's commentary there appear many examples of using a place-value Sanskrit system of numerals. One of the most interesting aspects of the commentary, however, is Govindasvami's construction of a sine table.

Shankaranarayana

Shankaranarayana (840-900 CE) was an Indian astronomer and mathematician. He was a disciple of the astronomer and mathematician Govindasvami. His most famous work was the 'Laghubhas kariyavivarana', written in 869 CE, which was a commentary on the Laghubhaskariya of Bhaskara I which in turn is based on the work of Aryabhata I.

Sridhara

He was born around 870 CE possibly in Bengal, India. Sridhara is known as the author of two mathematical treatises, namely the 'Trisatika' (sometimes called the Patiganitasara) and the 'Patiganita'. Sridhara was one of the first mathematicians to give a rule to solve a quadratic equation. Most of the original manuscripts are no longer available, and the only source of information about him is from the works of Bhaskara II. One rule for solving a quadratic equation is shown below: Multiply both sides of the equation by a known quantity equal to four times the coefficient of the square of the unknown; add to both sides a known quantity equal to the square of the coefficient of the unknown; then take the square root.

He died around the year 930 CE.

Âryabhata II

Âryabhata II (920-1000CE) was an Indian mathematician and astronomer, and the author of the 'Maha-Siddhanta'. The numeral II is given to him to distinguish him from the earlier and more influential Âryabhata I.

Maha-Siddhanta consists of 18 chapters and was written in the form of verses in Sanskrit. The initial 12 chapters deal with topics related to mathematical astronomy and covers the topics that Indian mathematicians of that period had already worked on.

Aryabhata II also deduced a method to calculate the cube root of a number, but his method was already given by Aryabhata I, many years earlier. Indian mathematicians were very keen to give the correct sine tables since they played a vital role to calculate the planetary positions as accurately as possible. Aryabhata II played a vital role in it by constructing a sine table, which was accurate up to five decimal places.

Pavuluri Mallana

Pavuluri Mallana, who followed Adikavi Nannaya is a mathematician of 11th century. He composed 'Ganitam', the first Telugu rendering of an original Sanskrit work on mathematics.

He was a contemporary of king Rajaraja Narendra. He has translated 'Ganitasara', a mathematical treatise of Mahivaracharya into Telugu language as 'Sara Sangraha Ganitamu'. He also wrote 'Bhadradri Rama Satakamu' published by Vavilla Ramaswamy Sastrulu and sons in 1916.

Rajaraja Narendra has donated Navakhandavada Agraharam near Pithapuram to a Brahmin named Mallana. His grandson also named Mallana is the famous writer. The Pavuluru village is presently in Parchuru Mandal of Prakasam district.

Bhâskara II (Bhaskaracharya)

Bhâskara II (1114-1185 CE), also known as Bhâskarâchârya ("Bhâskara the teacher"), was an Indian mathematician and astronomer. He was born near Vijayavada. Bhâskara is alleged to have been the Head of an astronomical observatory at Ujjain, the leading mathematical center of ancient India. He lived in the Sahyadri region.

Bhâskara and his works represent a significant contribution to mathematical and astronomical knowledge in the 12th century. He has been called the greatest mathematician of medieval India. His main work the 'Siddhânta Shiromani', Sanskrit for "Crown of treatises," is divided into four parts called Lilâvati, Bijaganita, Grahaganita and Golâdhyâya. These four sections deal with arithmetics, algebra, mathematics of the planets, and spheres respectively.

Bhâskara's work on calculus predates Newton and Leibniz by half a millennium. He is particularly known in the discovery of the principles of differential calculus and its application to astronomical problems and computations. While Newton and Leibniz have been credited with differential and integral calculus, there is strong evidence to suggest that Bhâskara was a pioneer in some of the principles of differential calculus. He was perhaps the first to conceive the idea of differential coefficient and differential calculus.

Medieval to Mughal period mathematicians

Narayana Pandit

Narayana Pandit (1340-1400 CE) was a major mathematician of India. The most that is known about him is that his father's name was Nrsimha or Narasimha. Also, the distribution of the manuscripts of his works suggests that he may have lived and worked in the northern part of India.

Narayana Pandit had written two works: 'Ganita Kaumudi' and 'Bijaganita Vatamsa'. Ganita Kaumudi written in 1356 CE is about mathematical operations. The work anticipated many developments in combinatorics. Bijaganita Vatamsa is an algebraic treatise. He is also thought to be the author of an elaborate commentary of Bhaskara II's Lilavati, titled 'Karmapradipika' (or Karma-Paddhati). Although Karmapradipika contains little original work, it contains

seven different methods for squaring numbers, a contribution that is wholly original to the author, as well as contributions to algebra and magic squares.

Narayana's other major works contain a variety of mathematical developments, including a rule to calculate approximate values of square roots, investigations into the second order indeterminate equation $nq^2 + 1 = p^2$ (Pell's equation), solutions of indeterminate higher-order equations, mathematical operations with zero, several geometrical rules, and a discussion of magic squares and similar figures. Evidence also exists that Narayana made minor contributions to the ideas of differential calculus found in Bhaskara II's work. Narayana has also made contributions to the topic of cyclic quadrilaterals. Narayana is also credited with developing a method for systematic generation of all permutations of a given sequence.

Mâdhava of Sañgamâgrama

Mâdhava of Sañgamâgrama (c. 1350 CE - c. 1425 CE) was a prominent Kerala mathematician-astronomer from the town of Irinjalakuda near Thrissur, Kerala. He is considered as the founder of the Kerala School of Astronomy and Mathematics. He was the first to have developed infinite series approximations for a range of trigonometric functions, which has been called the "decisive step onward from the finite procedures of ancient mathematics to treat their limit-passage to infinity". His discoveries opened the doors to what has today come to be known as Mathematical Analysis. One of the greatest mathematician-astronomers of the Middle Ages, Mâdhavan made pioneering contributions to the study of infinite series, calculus, trigonometry, geometry and algebra.

Vatasseri Parameshwaran Nambudiri

Vatasseri Parameshwaran Nambudiri was a 15th century astronomer and mathematician from Kerala. Parameshwaran Nambudiri (1360-1450 CE) was born in Vatasseri Mana (a Nambudiri Brahmin family) on the northern bank of the Nila River (Bharathapuzha) near Aswatha Gramam (near present Tirur of Malappuram district). He was a Rigvedi of the Bhrigu Gothram. He belonged to the Kerala school of astronomy and mathematics. He was also an astrologer. He was a proponent of observationl astronomy in medieval India and he himself had made a series of eclipse observations to verify the accuracy of the computational methods then in use. Based on his eclipse observations, he proposed several corrections to the astronomical parameters which had been in use since the times of Aryabhata. The computational scheme based on the revised set of parameters has come to be known as the Drgganita system. He was also a prolific writer on matters relating to astronomy. At least 25 manuscripts have been identified as being authored by Parameshwaran.

Kelallur Nilakantha Somayaji

Kelallur Nilakantha Somayaji (1444-1544CE) (also referred to as Kelallur

Comatiri) was a prominent mathematician and astronomer of the Kerala school of astronomy and mathematics.

Nilakantha was born in a Brahmin family which came from South Malabar in Kerala. He was born in a house called Kelallur which it is claimed coincides with the present Etamana in the village of Trikkantiyur near Tirur in south India. His father was Jataveda and the family belonged to the Gargya Gotra. He was a student of Damodra who was the son of Parameshwaran.

One of his most influential works was the comprehensive astronomical treatise 'Tantrasamgraha' completed in 1501. Tantrasamgraha is very important in terms of the mathematics Nilakantha uses. In particular he uses results discovered by Madhava and it is an important source of the remarkable mathematical results which he discovered. However, Nilakantha does not just use Madhava's results, he extends them and improves them. He had also composed an elaborate commentary on Aryabhatiya called the Aryabhatiyabhasya. In this, Nilakantha had discussed infinite series expansions of trigonometric functions and problems of algebra and spherical geometry.

Mahendra Sûri

Mahendra Sûri who lived between 1340 CE to 1410 CE was an Indian mathematician and follower of Jain. He wrote the 'Yantraraja', the first Indian treatise on the astrolabe in 1370 CE.

Sankara Variar

Sankara Variar (around 1500 - 1560 CE) was an astronomer-mathematician of the Kerala school of astronomy and mathematics. His family was employed as temple-assistants in the Shiva-temple at Trikkutaveli near modern Ottapalam. He was taught mainly by Nilakantha Somayaji and Jyesthadeva. The known works of Sankara Variar are 'Yukti Dipika', 'Laghu Vivrti' and 'Kriya Kramakari'. He also wrote an astronomical commentary dated 1529 CE and an astronomical handbook completed around 1554 CE.

Vasudeva Sarvabhauma

Vasudeva Sarvabhauma (1450-1525 CE) was born in a Bengali Brahmin family in Navadvipa. His father was the famous logician Narahari Visarada Bhattacharya. From a young age Vasudeva was trained by his father in Sanskrit grammar and literature. When he was 25 he travelled to Mithila to study Navya-nyaya (a new system of logic) under the famous Nyayanika Paksadhara Misra. Paksadhara admitted him into his academy and after finishing his studies he was given the title 'Sarvabhauma' (conqueror). However, the logicians of Mithila did not allow outsiders to copy their texts, therefore Vasudeva memorised a large part of Gangesa Upadhyaya's Tattva Chintamani and almost the whole of Nyaya Kusumanjali.

After a brief stay in Benares where he studied Vedanta and Mimamsa, Vasudeva Sarvabhauma returned to Navadvipa

where he opened his own school and taught Navya-nyaya. He soon became the foremost logician of his time and hundreds of students flocked to his academy to learn the Navya-nyaya system.

Raghunatha Shiromani

Raghunatha Shiromani (c. 1477 - 1547 CE) was an Indian philosopher and logician. He was born at Navadvipa (present day Nadia district of West Bengal state). He was a pupil of Vâsudeva Sârvabhauma. He brough
of Nyaya, Navya Nyâya, representing the final development of Indian formal logic, to its zenith of analytic power. Raghunatha's analysis of relations revealed the true nature of number, inseparable from the abstraction of natural phenomena, and his studies of metaphysics dealt with the negation or non-existence of a complex reality. His most famous work in logic was the Tattvacintâmanididhiti, a commentary on the Tattvacintâmani of Gangeœa Upâdhyâya, founder of the Navya Nyâya school. His other famous works include Pratyaksamani-didhiti, Anumana-didhiti, Padartha-khandana, Dravyakiranavali, Prakashadidhiti, Gunakiranavali-didhiti, Atmatattva-viveka-didhiti, Nyaya-lilavati-prakasha-didhiti, Krtisadhyanumanadidhiti, and Vajapeyavada.

Jyesthadeva

Jyesthadeva (c. 1500 - c. 1610 CE) belonged to the Kerala school of mathematics and he built on the work of Madhava, Nilakantha Somayaji, Parameswara and others. Jyesthadeva wrote a famous text Yuktibhasa in 1530 CE in Malayalam, the regional language of Kerala. The work is a survey of Kerala mathematics and, very unusually for an Indian mathematical text, it contains proofs of the theorems and gives derivations of the rules it contains. It is one of the main astronomical and mathematical texts produced by the Kerala School. An analysis of the mathematical content of Yuktibhâshâ has prompted some scholars to call it "the first textbook of calculus". The work was based mainly on the Tantrasamgraha of Nilakantha.

Achyuta Pishârati

Achyuta Pishârati (c. 1550 in Trikkandiyûr, Kerala - 7 July 1621) was a Sanskrit grammarian, astrologer, astronomer and mathematician who studied under Jyesthadeva and was a member of Kerala school of astronomy and mathematics. He is remembered mainly for his part in the composition of his student Melpathur Narayana Bhattathiri's devotional poem, Narayaneeyam.

He discovered the technique of 'the reduction of the ecliptic'. He authored Sphuta-nirnaya , Raasi-gola-sphuta neeti (raasi meaning zodiac, gola meaning sphere and neeti roughly meaning rule), Karanottama (1593) and a four-chapter treatise Uparagakriyakrama on lunar and solar eclipses.

Mathuranatha Tarkavagisha

Mathuranatha (born on c. 1575 CE) was a logician from Navadvipa school. He was

a Brahmin from a village named Manohari in Bengal. He was the son of a Naiyayika named Shrirama Tarkalankara. He underwent his primary education in Naya under his father. He then studied Nyaya under the great teacher, Shri Raghunatha Shiromani.

Mathuranatha has done commentaries on Tattvachintamani and Tattvachintamani didhiti named Mathuri and Rahasya. He has also written a commentary named Mathuri on Atmatattvaviveka and Kusumanjali. He has also authored a tika on Aloka of Pakshadhara Mishra, again named Mathuri. Both Aloka and Mathuri have never been printed till date. He has also written an independent work named Nyaya Rahasya.

Jagadisha Tarkalankara

Jagadisha Tarkalankara (born in c. 1625 CE) was a logician from Navadvipa school. He was the primary disciple of Bhavananda Tarkavagisha. His tika on Didhiti is popularly known as Jagadishi. Through his exhaustive commentary, especially on the Anumana Khanda and on Vyaptivada, he has outshined even Gangesha and Mathuranatha. He is also known to have written a commentary of Pakshadhara's Aloka. Shabdashakti prakashika, Tarkamrita and Nyayadarsha are his independent works.

Gadadhara Bhattacharya

Gadadhara Bhattacharya (born in c. 1650 CE) was the son of Jivacharya from Bengal. He studied Nyayashastra from Harirama Tarkavagisha of Navadvipa. He is the author of several well-known works such as Nyayakusumanjali Tika, Aloka Tika, Didhiti Tika, Durga Saptashati Tika, Bahya Nirnaya, Atmatattva Viveka Didhiti, Prakashika Gadadhari etc. He is also the author of 64 Vada granthas many of which are unavailable today. The available ones include Shaktivada, Vyutpattivada, Vishayatavada, Karanatavada, Muktivada, Sadrishyavada, Avacchedakavada, Paryaptivada, Navyamatavada, Akhyatavada, Smritisamskaravada, Karakavada etc.

Munishvara

Munishvara was a 17th century Indian mathematician who produced accurate sine tables.

Kamalakara

Kamalakara was an Indian astronomer and mathematician who came from a family of famous astronomers. He was born in c. 1616 CE in Benares (now Varanasi), and died in c. 1700 CE. He combined traditional Indian astronomy with Aristotelian physics and Ptolemaic astronomy as presented by Islamic scientists. Kamalakara's most famous work is the Siddhanta-tattva-viveka. The work was completed in 1658. It is a work of 15 chapters covering standard topics for Indian astronomy texts at that time.

The Siddhanta-tattva-viveka is a Sanskrit text and in it Kamalakara makes frequent use of the place-value number system with Sanskrit numerals. The third chapter of the Siddhanta-tattva-viveka contains some of the most interesting mathematical results. In that chapter

Kamalakara used the addition and subtraction theorems for the sine and the cosine to give trigonometric formulae for the sines and cosines of double, triple, quadruple and quintuple angles. In particular he gives formulae for sin (A/2) and sin (A/4) in terms of sin (A) and iterative formulae for sin (A/3) and sin (A/5).

Pandit Jagannatha Samrat

Pandit Jagannatha Samrat (1652-1744 CE) was an Indian astronomer and mathematician in the court of Jai Singh II of Amber. He learned Arabic and Persian in order to study Islamic astronomy. His works include Rekhaganita, a translation of Euclid's Elements made from Nasir al-Din al-Tusi's Arabic recension of the same; Siddhantasaraka ustubha, a translation of the Almagest from Arabic; and two works on astronomical instruments such as the astrolabe, Siddhanta-samrat and Yantraprakara, which also record astronomical observations made by Jagannatha.

Mathematicians born in 1800s

Ramchandra

Ramchandra (1821-1880) was British India's first major mathematician. His book, Treatise on Problems of Maxima and Minima, was promoted by the prominent mathematician Augustus De Morgan. De Morgan, in his introduction to Ramchandra's book says that he was born in 1821 in Panipat to Sunder Lal, a Kayasth of Delhi. De Morgan came to know of Ramchandra when, in 1850, he was sent by a friend a work on maxima and minima by the 29-year old self-taught mathematician. Ramchandra had published his book at his own expense in Calcutta during year. De Morgan arranged for the book to be republished in London under his own supervision. He was so impressed that he undertook to bring Ramchandra's work to the notice of scientific men of Europe.

Ramchandra was a teacher of science in Delhi College for some time. In 1858, he was native Head Master in Thomason Civil Engineering College (now Indian Institute of Technology, Roorkee) at Roorkee. Later that year, he was appointed Head Master of a school in Delhi.

Ganesh Prasad

Ganesh Prasad, born on 15 November 1876 at Ballia, Uttar Pradesh, was an Indian mathematician who specialized in the theory of potentials, theory of functions of a real variable, Fourier series and the theory of surfaces. He was trained at the Universities of Cambridge and Gottingen and on return to India he helped develop the culture of mathematical research in India. He was a founder member of the National Institute of Sciences, India, which has now been rechristened as the Indian National Science Academy. He authored 11 books including A Treatise on Spherical

Harmonics and the Functions of Bessel and Lame and over 50 research papers in mathematics. The mathematical community of India considers Ganesh Prasad as the Father of Mathematical Research in India. He was also an educator taking special interest in the advancement of primary education in the rural areas of India. He died on 9 March 1935.

Srinivasa Iyengar Ramanujan

Srinivasa Iyengar Ramanujan (22 December 1887 - 26 April 1920) was an Indian mathematician and autodidact who, with almost no formal training in pure mathematics, made substantial contributions to mathematical analysis, number theory, infinite series and continued fractions. He was one of India's greatest mathematical geniuses.

Born in Erode, Tamil Nadu, Ramanujan first encountered formal mathematics at age 10. He demonstrated a natural ability, and was given books on advanced trigonometry written by S.L. Loney. He mastered them by age 12, and even discovered theorems of his own, including independently re-discovering Euler's Identity. He demonstrated unusual mathematical skills at school, winning accolades and awards. By 17, Ramanujan conducted his own mathematical research on Bernoulli numbers and the Euler-Mascheroni constant. He received a scholarship to study at Government College in Kumbakonam, but lost it when he failed his non-mathematical course work. He joined another College to pursue independent mathematical research, working as a clerk in the Accountant-General's office at the Madras Port Trust Office to support himself. In 1912-1913, he sent samples of his theorems to three academics at the University of Cambridge. Only G.H. Hardy recognized the brilliance of his work, subsequently inviting Ramanujan to visit and work with him at Cambridge. He became a Fellow of the Royal Society and a Fellow of Trinity College, Cambridge. He died of illness, malnutrition and possibly liver infection in 1920 at the age of 32.

During his short lifespan, Ramanujan independently compiled nearly 3900 results (mostly identities and equations). Although a small number of these results were actually false and some were already known, most of his claims have now been proven correct. He stated results that were both original and highly unconventional, such as the Ramanujan prime and the Ramanujan theta function, and these have inspired a vast amount of further research. However, the mathematical mainstream has been rather slow in absorbing some of his major discoveries. Recently, Ramanujan's formulae have found applications in crystallography and string theory. The Ramanujan Journal, an international publication, was launched to publish work in all areas of mathematics influenced by his work.

A.A. Krishnaswami Ayyangar

A.A. Krishnaswami Ayyangar was born on 1 December, 1892. He got his M.A. in Mathematics at the age of 18 and subsequently started teaching Mathematics at his own alma mater, Pachaiappas College, Chennai (Madras). In 1918 he joined the Mathematics Department, University of Mysore and retired from there in 1947. He passed away in June 1953. During his tenure at the University, for nearly three decades, he made many contributions to Geometry, Statistics, Astronomy, the History of Indian Mathematics, and other topics.

His papers include: Ancient Hindu Mathematics (1921); The Hindu sine Table (1923-24); The mathematics of Aryabhata (1926); The Hindu Arabic numerals (2 parts) (1928,1929); Bhaskara and Samclishta kuttaka (1929-30); New light on Bhaskara's Chakravala or cyclic method of solving indeterminate equations of the second degree in two variables (1929-30); New proofs of old theorems - Apollonius and Brahmagupta (1920-30); Astronomy - Past and present (1930); Some glimpses of ancient Hindu mathematics (1933); Fourteen calendars (1937); A new continued fraction (1937-38); The Bhakshali manuscript (1939); Theory of the nearest square continued fraction (2 parts) (1940, 1941); Peeps into India's mathematical past (1945); and Remarks on Bhaskara's approximation to the sine of an angle (1950).

Raghunath Purushottam Paranjpe

Sir Raghunath Purushottam Paranjpe (16 February 1876 - 6 May 1966) was the first Indian to achieve the coveted title of Senior Wrangler at the University of Cambridge, and became a university administrator and Indian ambassador. R. P. Paranjpe was born at Murdi near Dapoli in the coastal Ratnagiri district of Maharashtra. He was educated at Maratha High, Bombay, Fergusson College, Pune and Bombay University before entering St. John's College, Cambridge in 1896. He graduated B.A. as senior wrangler in 1899. Paranjpe was a Fellow of St. John's College from 1901 to 1907, but returned to India to become a Professor of Mathematics at Fergusson College in 1902. One of the earliest Indian documentary film makers, H.S. Bhatavdekar, made silent documentary films named Return of Wrangler Paranjpye (1902) and Delhi Durbar of Lord Curzon (1903), featuring R.P.

In 1907, R.P. became the first librarian of the Indian Mathematical Society at Fergusson College. He became the College's Principal, and stayed in that position for two decades, until 1926. Subsequently, he became the Vice-Chancellor of Bombay University and Lucknow University.

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RACIAL DISCRIMINATION BY HIV !!!!

Prof. Ashish Swarup Verma and Anchal Singh

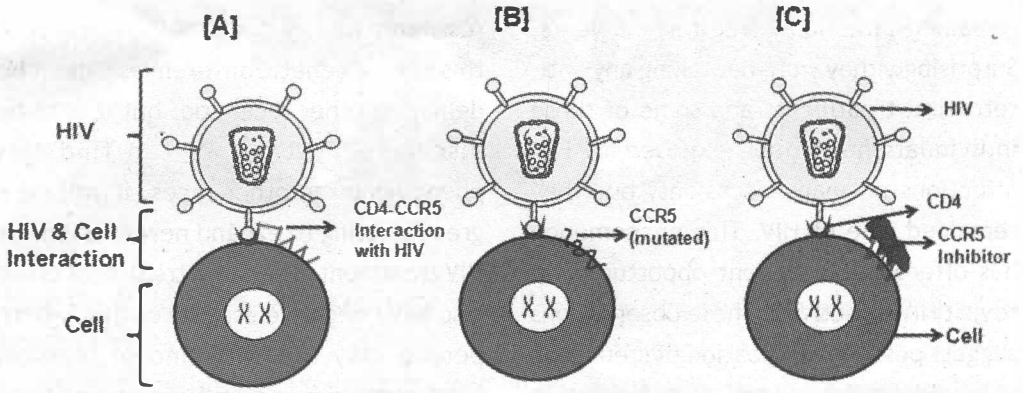
Discrimination is an inherent behavior of human which is common in everyday life. Discrimination can be on the basis of caste, religion, sex and even regional basis. At some point of time in our lives, we face discrimination at work, classroom or even at cafeteria. In international settings, people face discrimination based on race and nationality. Rationale for these discriminations is difficult to grasp, even though every one of us faces it in our life at one point or another. We will like to bring readers' attentio
of discrimination, which is very much unexpected and unimaginable. It is surprising to know that microbes also do discriminate us, which could have both good and bad consequences. Microbes are microscopic organism, e.g. bacteria, fungi, etc. known to have various beneficial as well as harmful effects. Microorganism like *Staphylococcus*, *Mycobacterium*, Herpes Simplex Virus (HSV), etc. are identified as causative organism for different diseases, some of them can be cured, while some can only be controlled by medical interventions. Similarly, Human Immunodeficiency Virus (HIV) is a retrovirus and causes Acquired Immune Deficiency Syndrome (AIDS). In this article we shed some light about discriminations shown by HIV to infect humans on the basis of their race. Cases of HIV/AIDS were reported for the first time in 1981 and soon numerous HIV infections were reported throughout the world. HIV infects all age groups, both sexes and all races, with impunity. Azidothymidine (AZT) was the first drug approved by Federal Drug Administration (FDA), USA to treat HIV. Later other drugs were also developed to treat HIV infection, and newer drugs are more effective. At present, Highly Active Anti-Retroviral Treatment (HAART) is used to treat HIV infections. So far all efforts to develop HIV vaccine went in vein and all efforts to control HIV went down the drain. The fact still remains that, "HIV infection can only be controlled and cannot be cured". It means that once someone is infected with HIV, he/she will have to remain infected through out his/her life, the only thing that anti-HIV drugs can do is to decrease HIV replication

significantly which slows down disease progression. As a result, life-span of HIV infected patients has increased significantly. Knowing all the facts about HIV, if someone comes to know, that no matter what happens he/she cannot be infected with HIV, he/she will feel blessed for having this eternal gift and will feel fortunate for himself/herself. In real-life there is a possibility that it exists, but hardly a few people know about it. The reason behind this possibility is discussed in the following text.

HIV infects T-lymphocytes in human which form a particular subset of lymphocytes. These cells are known as T-helper cells and they have special kind of receptors known as CD4 receptors. CD4 is a primary receptor for HIV infection. Previously it was believed that only CD4 receptors are essential for HIV infection. Further evidences suggested that for HIV infections, other receptors are also important. These receptors are classified as co-receptors, and they are of two types - CXCR4 and CCR5. On the basis of co-receptors essential for HIV infections, HIV is further classified into two categories as per their infectivity profiles. R5 strains of HIV infect *via* CCR5 co-receptor, while X-4 strains infect cells *via.* CXCR4 co-receptor. So there is always a possibility, that if an individual does not express either one of these co-receptors he/she should be resistant to HIV infections. To prove this possibility only thing required is to find this aberration in the real life. If we can show this evidence it can be called as "natural resistance" against HIV.

It is a well known fact that normal human being does not have T-cells (T-helper) without CD4 receptors. But, there may be the possibilities that CCR5 may either be absent or altered. If either of before-mentioned possibility does exist in any individual they are expected to show resistance against HIV infection. Further observations suggest that these possibilities do exist in human. This conclusion is derived from the fact that some of the high risk individuals (for HIV infections) never got HIV infections. This observation has significant implications to understand infection mechanism with new perspective which will help to develop new strategies for treatment and prevention of HIV.

For an understanding about the role of chemokine receptor either in HIV infections or conversely, an understanding of its role in protection against HIV infection is essential. HIV on its surface has different proteins, which unfold and interact with receptors present on T-cells (T-helper). This process takes place when a HIV virion reaches the vicinity of T-cell to be infected by HIV. Interaction of HIV surface proteins with CD4 receptors on T-cells leads to alterations in HIV surface protein. These changes support HIV binding with co-receptors like CCR5. Interaction and binding of HIV surface proteins with CD4 receptors and co-receptor (CCR5) leads to fusion of HIV with T-cells (T-helper). Fusion of viral outer membrane with T-cells leads to delivery of viral genomic material in to the cell. This starts production of new viral particle



This figure is a graphical representation of CD4 receptor and CCR5 co-receptors binding with HIV proteins. Binding with CD4 and CCR5 is essential for HIV infectivity to T-cell (T-helper). [A]. It is a graphical representation of interaction of CCR5 and CD4 in normal infection process, when CCR5 receptors are normal. [B]. It is graphical representation of mutated CCR5 co-receptor, that is observed in some Caucasian individuals who are naturally resistant to HIV infections. CCR5 co-receptor is mutated in these cases, therefore HIV and CD4 receptors interaction will not occur[C]. It is a graphical representation where different agents as drug can be designed to block CCR5 co-receptors. If CCR5 co-receptor is blocked, HIV will not infect the cells.

from newly infected cells (Fig 1A). HIV cannot infect T-cells, if CCR5 as a co-receptor is modified (Fig 1B) or blocked by some other protein biomolecules or if binding with CCR3 fails (Fig. 1C).

Detailed studies revealed a better understanding about the role of co-receptors for non-infectivity of HIV. "Naturally Resistant" individuals were studied and found that co-receptor (CCR5) is not functional. That is the reason y these individuals show natural resistance to HIV. This observations were also confirmed in laboratory by infecting T-cells (T-helper) from naturally resistant individual with HIV and these cells failed to get infected with HIV.

These alterations are known as Ä32 alleles, because this gene showed a deletion of 32 bp from the original gene sequence. In general, any gene in a human comes from two individuals i.e., one set comes from father, while other one comes from mother. So when this deletion is present on both chromosomes, the condition is known as homozygous. In some individuals only one set of gene is showing this deletion, then it is called as heterozygous condition. This heterozygous condition can arise due to the presence of mutation either from mother or from father.

Homozygous or heterozygous condition for Ä32 has also its importance in terms of HIV infectivity. Homozygous individuals turned out to be completely resistant to HIV infections, while heterozygous individuals are vulnerable to HIV infections, but the progression of HIV infection or disease is significantly lower than individuals who are not resistant to HIV infections.

Individuals with these mutations remained alive and free from HIV

infections for >10 years, even some remained infection - free for >30 years. Surprisingly they were not taking any anti-retroviral treatments and some of those individuals have been exposed to HIV infections on many occasions, but they remained free of HIV. This phenomenon has offered an excellent opportunity to revisit HIV infectivity. These observations suggest possible implication of stem cells or bone marrow stem cells transplantation as a new hope to cure HIV infections. Bone marrow transplantation is one of the most useful applications for this kind of phenomenon. If this becomes successful option, it will ameliorate miseries of HIV seropositives with HIV related complications as well as serious side effects of various anti-retrovirals. If these treatments turn out to be successful, HIV seropositives can lead a good life along with the drop in expenditure on regular supply of medications.

Another clue from this phenomenon is that, if we block CCR5 co-receptor for HIV entry it will effectively inhibit the entry of HIV into cells. There are various successful attempts to block CCR5 co-receptors with different blockers. Therapeutic approaches to treat HIV by blocking CCR5 have its own limitation, which needs intensive studies to overcome these limitations. The natural resistance against HIV infections has been observed only in Caucasians (generally white people from European descent). So far, the phenomenon of natural resistance has not been reported from any other race. Basically it is not the race; it is the genetics, which is making some individuals resistant to HIV infection. Possibilities of this kind of genetic differences cannot be denied in other races too, but it is to be discovered yet. If we can find this phenomenon in other races, it will be a great blessing to expand new avenues for HIV treatment. The same treatment could also have negative aspects of this, where people may use this kind of medical treatment with impunity. So on one hand people who have undergone this kind of medical treatment will protect themselves, but they may become a reasonable risk for the transmission of HIV infection to other unprotected individuals. Let us hope that this mutation exists in other races too, and we may be able to identify them to protect people from miseries of HIV infections.

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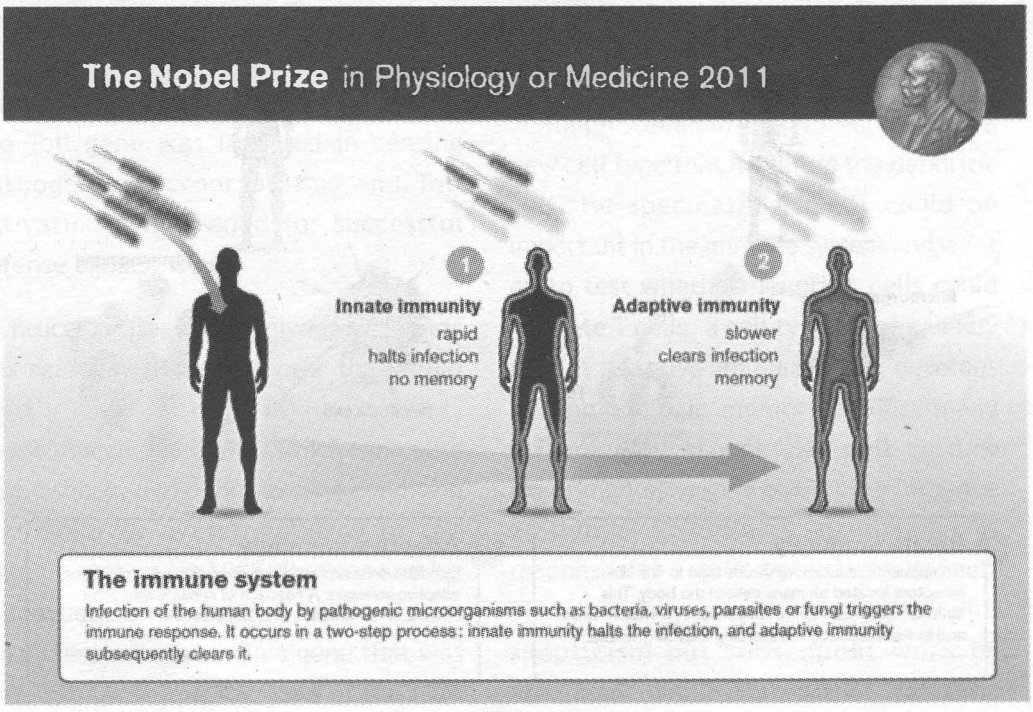
NOBEL PRIZES IN SCIENCE : 2011

Nobel Prize in Physiology or Medicine

Three scientists who "revolutionized" the understanding of how the body fights infection have shared this year's Nobel Prize for Medicine. **Bruce Beutler** of the US, **Jules Hoffmann** from Luxembourg and **Ralph Steinman** from Canada shared the prize. Beutler and Hoffman were awarded *"for their discoveries concerning the activation of innate immunity"* and Steinman *"for the discovery of the dendritic cell and its role in adaptive immunity"*.

Scientists have long been searching for the gatekeepers of the immune response by which man and other animals defend themselves against attack by bacteria and other microorganisms. Bruce Beutler and Jules Hoffmann discovered receptor proteins that can recognize such microorganisms and activate innate immunity, the first step in the body's immune response. Ralph Steinman discovered the dendritic cells of the immune system and their unique capacity to activate and regulate adaptive


The Nobel Prize in Physiology or Medicine 2011
1
Innate immunity
rapid
halts infection
no memory
2
Adaptive immunity
slower
clears infection
memory
The immune system
Infection of the human body by pathogenic microorganisms such as bacteria, viruses, parasites or fungi triggers the immune response. It occurs in a two-step process: innate immunity halts the infection, and adaptive immunity subsequently clears it.

immunity, the later stage of the immune response during which microorganisms are cleared from the body.

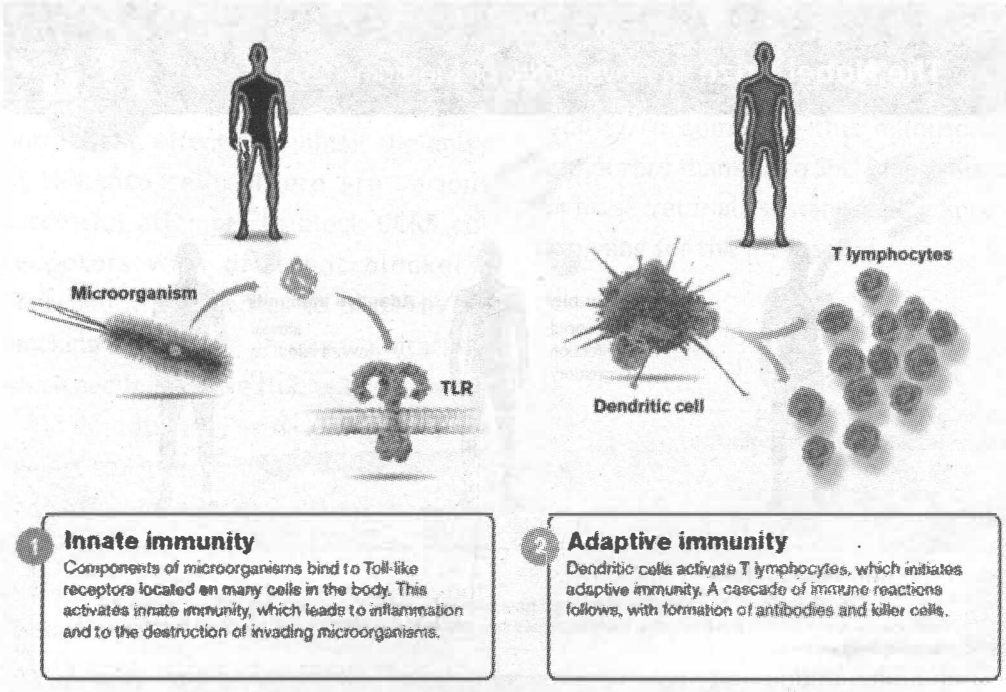
The discoveries of the three Nobel Laureates have revealed how the innate and adaptive phases of the immune response are activated and thereby provided novel insights into disease mechanisms. Their work has opened up new avenues for the development of prevention and therapy against infections, cancer, and inflammatory diseases.

The Twin Faces of Defense

We live in a dangerous world. Pathogenic microorganisms (bacteria, virus, fungi, and parasites) threaten us continuously but we are equipped with powerful defense mechanisms. The first line of defense, *innate immunity*, can destroy invading microorganisms and trigger inflammation that contributes to blocking their assault. If microorganisms break through this defense line, *adaptive immunity* is called into action. With its T and B cells, it produces antibodies and killer cells that destroy infected cells.

After successfully combating the infectious assault, our adaptive immune system maintains an immunologic memory that allows a more rapid and powerful mobilization of defense forces next time the same microorganism attacks. These two defense lines of the immune system provide good protection against infections but they also pose a risk. If the activation threshold is too low, or if endogenous molecules can activate the system, inflammatory disease may follow.

The components of the immune system have been identified step by step during the 20th century. Thanks to a series of


Microorganism
TLR
T lymphocytes
Dendritic cell
1 Innate immunity
Components of microorganisms bind to Toll-like receptors located on many cells in the body. This activates innate immunity, which leads to inflammation and to the destruction of invading microorganisms.
2 Adaptive immunity
Dendritic cells activate T lymphocytes, which initiates adaptive immunity. A cascade of immune reactions follows, with formation of antibodies and killer cells.

discoveries awarded the Nobel Prize, we know, for instance, how antibodies are constructed and how T cells recognize foreign substances. However, until the work of Beutler, Hoffmann and Steinman, the mechanisms triggering the activation of innate immunity and mediating the communication between innate and adaptive immunity remained enigmatic.

Discovering the Sensors of Immunity

Jules Hoffmann made his pioneering discovery in 1996, when he and his co-workers at University of Strasbourg in France investigated how fruit flies combat infections. They had access to flies with mutations in several different genes including Toll, a gene previously found to be involved in embryonal development by Christiane Nusslein-Volhard (Nobel Prize 1995). When Hoffmann infected his fruit flies with bacteria or fungi, he discovered that Toll mutants died because they could not mount an effective defense. He was also able to conclude that the product of the Toll gene was involved in sensing pathogenic microorganisms and Toll activation was needed for successful defense against them.

Bruce Beutler in the University of Texas was searching for a receptor that could bind the bacterial product, lipopolysaccharide (LPS), which can cause septic shock, a life threatening condition that involves overstimulation of the immune system. In 1998, Beutler and his colleagues discovered that mice resistant to LPS had a mutation in a gene that was quite similar to the Toll gene of the fruit fly. This Toll-like receptor (TLR) turned out to be the elusive LPS receptor. When it binds LPS, signals are activated that cause inflammation and, when LPS doses are excessive, septic shock. These findings showed that mammals and fruit flies use similar molecules to activate innate immunity when encountering pathogenic microorganisms.

The discovery of the sensors of innate immunity by Hoffmann and Beutler triggered an explosion of research in innate immunity. Around a dozen different TLRs have now been identified in humans and mice. Each one of them recognizes certain types of molecules common in microorganisms. Individuals with certain mutations in these receptors carry an increased risk of infections while other genetic variants of TLR are associated with an increased risk for chronic inflammatory diseases.

Dendritic Cell and Adaptive Immunity

Ralph Steinman discovered, in 1973, a new cell type that he called the dendritic cell. He speculated that it could be important in the immune system and went on to test whether dendritic cells could activate T cells, a cell type that has a key role in adaptive immunity and develops an immunologic memory against many different substances. In cell culture experiments, he showed that the presence of dendritic cells resulted in vivid responses of T cells to such substances. These findings were initially met with skepticism but subsequent work by Steinman demonstrated that dendritic

cells have a unique capacity to activate T cells.

Further studies by Steinman and other scientists went on to address the question of how the adaptive immune system decides whether or not it should be activated when encountering various substances. Signals arising from the innate immune response and sensed by dendritic cells were shown to control T cell activation. This makes it possible for the immune system to react towards pathogenic microorganisms while avoiding an attack on the body's own endogenous molecules.

From Fundamental Research to Medical Use

The discoveries that are awarded the 2011 Nobel Prize have provided novel insights into the activation and regulation of our immune system. They have made possible the development of new methods for preventing and treating disease, for instance with improved vaccines against infections and in attempts to stimulate the immune system to attack tumors. These discoveries also help us understand why the immune system can attack our own tissues, thus providing clues for novel treatment of inflammatory diseases.

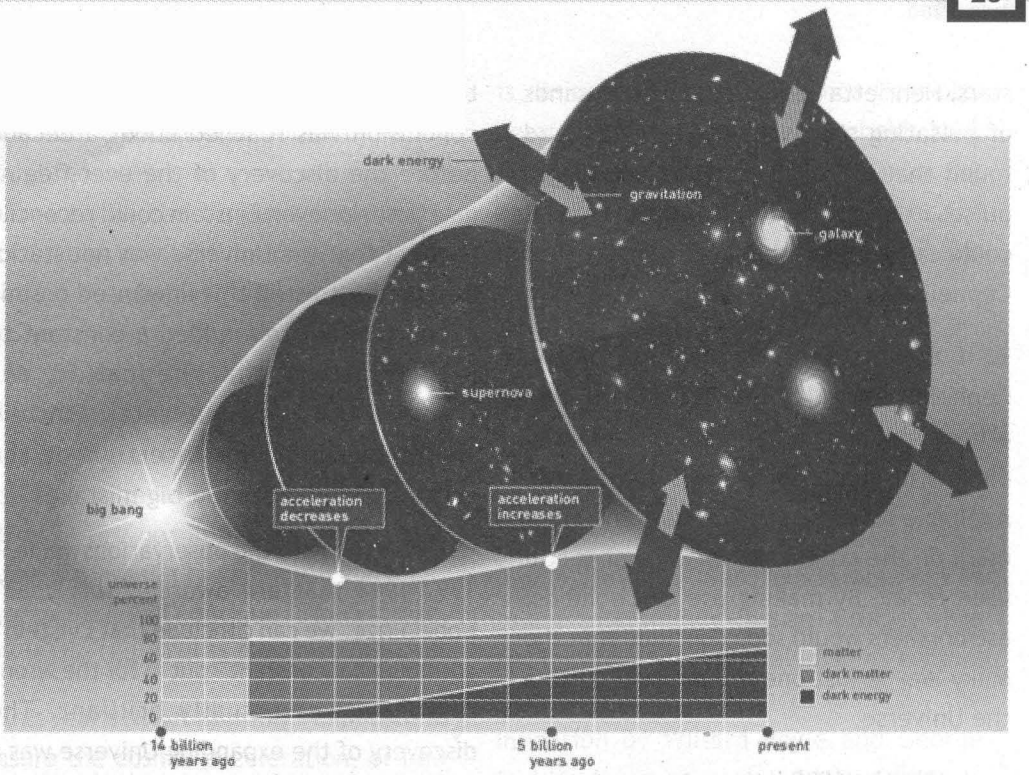
[Ralph M. Steinman died on Septernber 30, two days before the announcement of the Nobel Prize. According to the statutes of the Nobel Foundation, work produced by a person since deceased shall not be given the award. However, the statutes specify that if a person has been awarded a prize and has died before receiving it, the prize may be presented. And the decision to award the Nobel Prize to Ralph Steinman was made based on the assumption that the Nobel Laureate was alive. So, the Nobel Foundation decided not to withdraw Ralph Steinman's award].

The Nobel Prize in Physics

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2011 with one half to **Saul Perlmutter** and the other half jointly to **Brian P. Schmidt** and **Adam G. Riess** *"for the discovery of the accelerating expansion of the Universe through observations of distant supernovae".*

What is the fate of the Universe? Probably it will end in ice if we are to believe this year's Nobel Laureates. They have carefully studied several dozen exploding stars, called supernovae, in far away galaxies and have concluded that the expansion of the Universe is speeding up. The discovery came as a complete surprise even to the Nobel Laureates themselves. What they saw would be like throwing a ball up in the air, and instead of having it come back down, watching as it disappears more and more rapidly into the sky, as if gravity could not manage to reverse the ball's trajectory. Something similar seemed to be happening across the entire Universe.

The growing rate of the expansion implies that the Universe is being pushed apart by an unknown form of energy embedded in the fabric of space. This *dark energy* makes up a large part of the Universe, more than 70%, and it is an



The world is growing. The expansion of the Universe began with the Big Bang 14 billion years ago, but slowed down during the first several billion years. Eventually is strated to accelerate. The acceleration is believed to be driven by dark energy, which in the begining constituted only a small part of the Universee. But as matter got diluted by the expansion, the dark energy became more dominant

enigma, perhaps the greatest in physics today. No wonder, then, that cosmology was shaken at its foundations when two different research groups presented similar results in 1998. Saul Perlmutter headed one of the two research teams, the Supernova Cosmology Project, initiated a decade earlier in 1988. Brian Schmidt headed another team of scientists, which towards the end of 1994 launched a competing project, the High-z Supernova Search Team, in which Adam Riess was to play a crucial role.

The two research teams raced each other to map the Universe by finding the most distant supernovae, star explosions in space. By establishing the distance to the supernovae and the speed at which they are moving away from us, scientists hoped to reveal our cosmic fate. They expected to find signs that the expansion of the Universe was slowing down, which would lead to equilibrium between fire and ice. What they found was the opposite - the expansion was accelerating.

Cosmos is growing

It is not the first time that an astronomical discovery has revolutionized our ideas about the Universe. Only a hundred years ago, the Universe was considered to be a calm and peaceful place, no larger than our own galaxy, the Milky Way. Soon, however, a radical shift would change this picture. At the beginning of the 20th century the American astronomer Henrietta Swan Leavitt found a way of measuring distances to faraway

stars. Henrietta Leavitt studied thousands of pulsating stars, called *Cepheids*, and found that the brighter ones had longer pulses. Using this information, Leavitt could calculate the intrinsic brightness of Cepheids.

If the distance of just one of the Cepheid stars is known, the distances to other Cepheids can be established - the dimmer its light, the farther away the star. A reliable standard candle was born, a first mark on the cosmic yardstick that is still used today. By making use of Cepheids, astronomers would soon conclude that the Milky Way is just one of many galaxies in the Universe.

And in the 1920s, the astronomers got access to the world's then-largest telescope Mount Wilson in California, so they were able to show that almost all galaxies are moving away from us. They were studying the so-called *redshift* that occurs when a source of light is receding from us. The light's wavelength gets stretched, and the longer the wave, the redder its colour. The conclusion was that the galaxies are rushing away from us and each other, and the farther away they are, the faster they move - this is known as Hubble's Law.

The Growing Universe

What was observed in space had already been suggested by theoretical calculations. In 1915, Albert Einstein published his General Theory of Relativity, which has been the foundation of our understanding of the Universe ever since. The theory describes a Universe that has to either shrink or expand. This disturbing conclusion was reached about a decade before the discovery of the ever-fleeing galaxies. Not even Einstein could reconcile the fact that the Universe was not static. So in order to stop this unwanted cosmic expansion, Einstein added a constant to his equations that he called *the cosmological constant*. Later, Einstein would consider the insertion of the cosmological constant a big mistake.

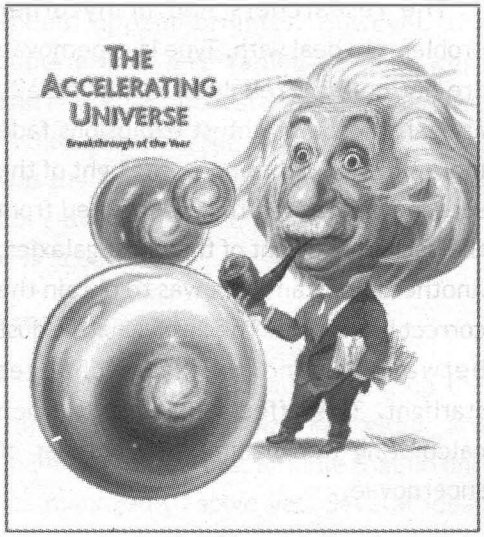
However, with the observations made in 1997-1998 that are awarded this year's Nobel Prize, we can conclude that Einstein's cosmological constant - put in for the wrong reasons - was actually brilliant. The discovery of the expanding Universe was a groundbreaking first step towards the now standard view that the Universe was created in the Big Bang almost 14 billion years ago. Both time and space began then. Ever since, the Universe has been expanding; like raisins in a raisin cake swelling in the oven, galaxies are moving away from each other due to the cosmological expansion. But where are we heading?

Supernovae - the new measure of the Universe

When Einstein got rid of the cosmological constant and surrendered to the idea of a non-static Universe, he related the geometrical shape of the Universe to its fate. Is it open or closed, or is it something in between - a flat Universe? An open Universe is one where the gravitational force of matter is not large enough to prevent the expansion of the Universe. All matter is then diluted in an ever larger, ever colder and ever more empty space.

In a closed Universe, on the other hand, the gravitational force is strong enough to halt and even reverse the expansion. So the Universe eventually would stop expanding and fall back together in a hot and violent ending, a *Big Crunch*. Most cosmologists, however, would prefer to live in the most simple and mathematically elegant Universe: a flat one, where the expansion is believed to decline. The Universe would thus end neither in fire nor in ice. But there is no choice. If there is a cosmological constant, the expansion will continue to accelerate, even if the Universe is flat.

This year's Nobel Laureates expected to measure the cosmic deceleration, or how the expansion of the Universe is slowing. Their method was in principle the same as the one used by astronomers more than six decades earlier: to locate distant stars and to measure how they move. However, that is easier said than done. Since Henrietta Leavitt's days many other Cepheids have been found that are even farther away. But at the distances that astronomers need to see, billions of light years away, Cepheids are no longer visible. The cosmic yardstick needed to be extended.



The accelerating expansion of the Universe was procalaimed 'Breakthrough of the Year' in the December 1998 issue of *Science*. On the cover, Albert Einstein gazed upon his cosmological constant, which has returned to the forefront of cosmology

Supernovae - the New Standard

More sophisticated telescopes on the ground and in space, as well as more powerful computers, opened the possibility in the 1990s to add more pieces to the cosmological puzzle. Crucial were the light-sensitive digital imaging sensors - charged-coupled devices or CCD - the invention by Willard Boyle and George Smith who were awarded Nobel Prize in Physics in 2009.

The newest tool in the astronomer's toolbox is a special kind of star explosion, the *type Ia supernova*. During a few weeks, a single such supernova can emit as much light as an entire galaxy. This type of supernova is the explosion of an extremely compact old star that is as heavy as the Sun but as small as the Earth - a *white dwarf*. The explosion is the final step in the white dwarf's life cycle. White dwarfs form when a star has no more energy at its core, as all hydrogen and helium have been burned in nuclear reactions. Only carbon and oxygen remain.

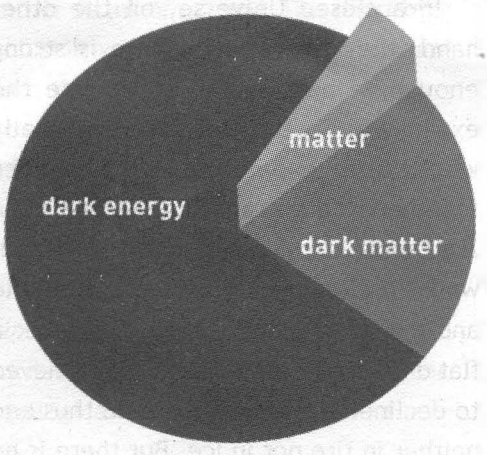
In the same way, far off in the future, our Sun will fade and cool down as it reaches its end as a white dwarf. A far more exciting end awaits a white dwarf that is part of a binary star system, which

is fairly common. In this case, the white dwarf's strong gravity robs the companion star of its gas. However, when the white dwarf has grown to 1.4 solar masses, it no longer manages to hold together. When this happens, the interior of the dwarf becomes sufficiently hot for runaway fusion reactions to start, and the star gets ripped apart in seconds.

The nuclear fusion products emit strong radiation that increases rapidly during the first weeks after the explosion, only to decrease over the following months. So there is a rush to find supernovae - their violent explosions are brief. Across the visible Universe, about ten type Ia supernovae occur every minute. But the Universe is huge. In a typical galaxy only one or two supernova explosions occur in thousand years. In September 2011, we were lucky to observe one such supernova in a galaxy close to the Big Dipper, visible just through a pair of regular binoculars. But most supernovae are much farther away and thus dimmer. So where and when would you look in the canopy of the sky?

An Astounding Conclusion

The two competing teams knew they had to comb the heavens for distant supernovae. The trick was to compare two images of the same small piece of the sky, corresponding to a thumbnail at arm's length. The first image has to be taken just after the new moon and the second three weeks later, before the moonlight swamps out starlight. Then the two images can be compared in the hope of discovering a small dot of light - which could be a sign of a supernova in a galaxy far away. Only supernovae farther than a third of the way across the visible Universe were used, in order to eliminate local distortions.



The implications of the discovery is that three quarters of the Universe is an unknwon form of energy, called dark energy. Together with equally unknown dark matter, the dark energy constitutes 95% of the Universe. Only the remaining 5% is reuglar matter that makes up galaxies, stars, flowers and humans

The researchers had many other problems to deal with. Type Ia supernovae are not quite as reliable as they initially appeared - the brightest explosions fade more slowly. Furthermore, the light of the supernovae needed to be extracted from the background light of their host galaxies. Another important task was to obtain the correct brightness. The inter-galactic dust between us and the stars changes starlight. This affects the results when calculating the maximum brightness of supernovae.

Chasing supernovae challenged not only the limits of science and technology but also those of logistics. First, the right kind of supernova had to be found.

Second, its redshift and brightness had to be measured. The light curve had to be analyzed over time in order to be able to compare it to other supernovae of the same type at known distances. This required a network of scientists that could decide quickly whether a particular star was a worthy candidate for observation. They needed to be able to switch between telescopes and have observation time at a telescope granted without delay, a procedure that usually takes months. They needed to act fast because a supernova fades quickly.

The potential pitfalls had been numerous, and the scientists actually were reassured by the fact that they had reached the same amazing results: all in all, they found some 50 distant supernovae whose light seemed weaker than expected. This was contrary to what they had envisioned. If cosmic expansion had been losing speed, the supernovae should appear brighter. However, the supernovae were fading as they were carried faster and faster away, embedded in their galaxies. The surprising conclusion was that the expansion of the Universe is not slowing down - quite to the contrary, it is accelerating.

From Here to Eternity

So what is it that is speeding up the Universe? It is called *dark energy* and is a challenge for physics, a riddle that no one has managed to solve yet. Several ideas have been proposed. The simplest is to reintroduce Einstein's cosmological constant, which he once rejected. At that time, he inserted the cosmological constant as an anti-gravitational force to counter the gravitational force of matter and thus create a static Universe. Today, the cosmological constant instead appears to make the expansion of the Universe to accelerate.

The cosmological constant is, of course, constant, and as such does not change over time. So dark energy becomes dominant when matter, and thus its gravity, gets diluted due to expansion of the Universe over billions of years. According to scientists, that would account for why the cosmological constant entered the scene so late in the history of the Universe, only five to six billion years ago. At about that time, the gravitational force of matter had weakened enough in relation to the cosmological constant. Until then, the expansion of the Universe had been decelerating.

It may be that the dark energy is not constant after all. Perhaps it changes over time. Perhaps an unknown force field only occasionally generates dark energy. In physics there are many such force fields that collectively go by the name *quintessence*, after the Greek name for the fifth element. Quintessence could speed up the Universe, but only sometimes. That would make it impossible to foresee the fate of the Universe.

According to current consensus, about three quarters of the Universe consist of dark energy. The rest is matter. But the regular matter, the stuff that galaxies, stars, humans and flowers are made of, is only five percent of the Universe. The

remaining matter is called *dark matter* and is so far hidden from us. Like dark energy, dark matter is invisible. Therefore the findings of the 2011 Nobel Laureates in Physics have helped to unveil a Universe that is to 95% unknown to science. And everything is possible again.

The Nobel Prize in Chemistry

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry for 2011 to **Dan Shechtman** from Technion - Israel Institute of Technology, for the *"discovery of quasi crystals"*.

When Daniel Shechtman entered the discovery awarded with the Nobel Prize in Chemistry 2011 into his notebook, he jotted down three question marks next to it. The atoms in the crystal in front of him yielded a forbidden symmetry. Since then, mosaics with intriguing patterns and the golden ratio in mathematics and art have helped scientists to explain Shechtman's bewildering observation.

It was the morning of 8 April 1982. The material he was studying, a mix of aluminum and manganese, was strange-looking, and he had turned to the electron microscope in order to observe it at the atomic level. However, the picture that the microscope produced was counter to all logic: he saw concentric circles, each made of ten bright dots at the same distance from each other. *"Eyn chaya kazo"*, he said to himself. "There can be no such creature" in Hebrew. In the pattern he observed, the atoms were arranged in a manner that was contrary to the laws of nature.

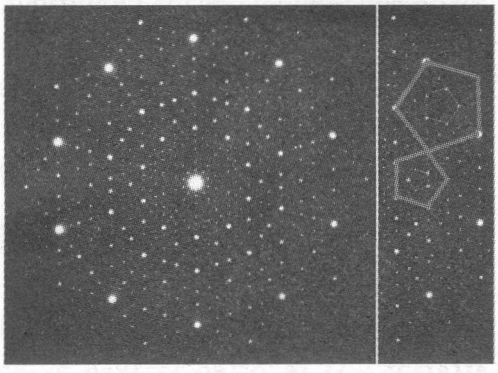
Crests and Troughs in Co-operation

In order to understand Shechtman's experiment and why he was so surprised, imagine the following class-room experiment. A physics teacher transmits light through a perforated metal plate, a so-called diffraction grating. When the light waves travel through the grating, they are refracted in the same manner as an ocean wave that moves through a gap in a breakwater. On the other side of the grating, waves spread in a semicircular manner and intersect with other waves. Crests and troughs of the waves reinforce and counteract each other. On a screen behind the diffraction grating, a pattern will appear of light and dark areas - a diffraction pattern.

It was such a diffraction pattern that Daniel Shechtman obtained that April morning in 1982. However, his experiment was different: he used electrons instead of light, his grating consisted of the atoms in the rapidly cooled metal, and he conducted his experiment in three dimensions. The diffraction pattern showed that the atoms inside the metal were packed into an ordered crystal. That in itself was nothing extraordinary. Almost all solid materials, from ice to gold, consist of ordered crystals. However, the diffraction pattern with ten bright dots arranged in a circle was something he had never seen before, despite his vast experience using electron microscopes.

Furthermore, such a crystal was not represented in the International Tables for Crystallography - the main

crystallographic reference guide. At the time, science plainly stipulated that a pattern with ten dots in a circle was impossible, and the proof for that was as simple as it was obvious. A pattern counter to all logic Inside a crystal, atoms are ordered in repeating patterns, and depending on the chemical composition, they have different symmetries. In figure 5a, we see that each atom is surrounded by three identical atoms in a repeating pattern, yielding a threefold symmetry. Rotate the image 120 degrees and the same pattern will appear.



Electron diffraction pattern from an icosahedral quasi crystal. Note the presence of perfect pentagons

Shechtman, however, could rotate his diffraction pattern by a tenth of a full circle (36 degrees) and still obtain the same pattern. Hence he was looking at a tenfold symmetry, one that was considered impossible. It is no surprise, then, that he made no less than three question marks in his notebook. Wrong according to the textbook Daniel Shechtman peeked out from his office into the corridor at the U.S. National Institute of Standards and Technology (NIST), wanting to find someone with whom he could share his discovery. But the corridor was empty, so he went back to the microscope to carry out further experiments on the peculiar crystal.

Among other things, he double-checked if he had obtained a twin crystal: two intergrown crystals whose shared boundary gives rise to strange diffraction patterns. But he could not detect any signs that he was in fact looking at a twin crystal. In addition to this, he rotated the crystal in the electron microscope in order to see how far he could turn it before the tenfold diffraction pattern reappeared. That experiment showed that the crystal itself did not have tenfold symmetry like the diffraction pattern, but was instead based on an equally impossible fivefold symmetry.

Daniel Shechtman concluded that the scientific community must be mistaken in its assumptions. When Shechtman told scientists about his discovery, he was faced with complete opposition, and some colleagues even resorted to ridicule. Many claimed that what he had observed was in fact a twin crystal. The head of the laboratory gave him a textbook of crystallography and suggested he should read it. Shechtman, of course, already knew what it said but trusted his experiments more than the textbook. All the commotion finally led his boss to ask him to leave the research group, as Schechtman himself recalled later. The situation had become too embarrassing.

Fighting Established Knowledge

Daniel Shechtman had obtained his Ph. D. from Technion - Israel Institute of Technology, and in 1983, he managed to

get Ilan Blech, a colleague at his alma mater, interested in his peculiar research findings. Together they attempted to interpret the diffraction pattern and translate it to the atomic pattern of a crystal. They submitted an article to the *Journal of Applied Physics* in the summer of 1984. But the article came back seemingly by return of post - the editor had refused it immediately.

Shechtman then asked John Cahn, a renowned physicist who had lured him over to NIST in the first place, to take a look at his data. The otherwise busy researcher eventually did, and in turn, Cahn consulted with a French crystallographer, Denis Gratias, in order to see if Shechtman could have missed something. But according to Gratias, Shechtman's experiments were reliable. Gratias would have proceeded in the same manner had he conducted the experiments himself. In November 1984, together with Cahn, Blech and Gratias, Shechtman finally got to publish his data in *Physical Review Letters*. The article went off like a bomb among crystallographers. It questioned the most fundamental truth of their science: that all crystals consist of repeating, periodic patterns.

The discovery now reached a wider audience, and Daniel Shechtman became the target of even more criticism. At the same time, however, crystallographers around the world had a moment of déjà vu. Many of them had obtained similar diffraction patterns during analyses of other materials, but had interpreted those patterns as evidence of twin crystals. Now they started digging around in their drawers for old laboratory notes, and pretty soon other crystals began to appear with seemingly impossible patterns, such as eight- and twelvefold symmetries. When Shechtman had published his discovery, he still had no clear grasp of what the strange crystal actually looked like on the inside. Evidently its symmetry was fivefold, but how were the atoms packed? The answer to that question would come from unexpected quarters: mathematical games with mosaics.

The Mosaics of Explanation

Mathematicians like to challenge themselves with puzzles and logic problems. During the 1960s, they began to ponder whether a mosaic could be laid with a limited number of tiles so that the pattern never repeated itself, to create a so-called *aperiodic* mosaic. The first successful attempt was reported in 1966 by an American mathematician, but it required more than 20,000 different tiles and was thus far from pleasing mathematicians' penchant for parsimony. As more and more people took on the challenge, the number of tiles required steadily shrank.

Finally, in the mid-1970s, a British Professor of Mathematics, Roger Penrose, provided a most elegant solution to the problem. He created aperiodic mosaics with just two different tiles, for example, a fat and a thin rhombus. Penrose's mosaics inspired the scientific community in several different ways. Among other things, his findings have since been used

to analyze medieval Islamic Girih patterns, and we have learned that Arabic artists produced aperiodic mosaics out of five unique tiles as early as the 13th century. Such mosaics decorate the extra-ordinary Alhambra Palace in Spain, for example, and portals and vaults of the Darb-i Imam Shrine in Iran.

The crystallographer Alan Mackay applied the Penrose mosaic in yet another manner. He was curious as to whether atoms, the building blocks of matter, could form aperiodic patterns like the mosaics. He conducted an experiment where he substituted circles, representing atoms, at intersections in the Penrose mosaic. He then used this pattern as a diffraction grating in order to see what kind of diffraction pattern this would yield. The result was a tenfold symmetry - ten bright dots in a circle.

The connection between Mackay's model and Shechtman's diffraction pattern was subsequently made by the physicists Paul Steinhardt and Dov Levine. Before Shechtman's article appeared in *Physical Review Letters*, the editor sent it off to other scientists for review. During this process, Steinhardt got the opportunity to read it. He was already acquainted with Mackay's model, and realized that Mackay's theoretical tenfold symmetry existed in real life in Shechtman's laboratory at NIST. On Christmas Eve, 1984, only five weeks after Shechtman's article appeared in print, Steinhardt and Levine published an article where they described quasi crystals and their aperiodic mosaics. Quasi crystals got their name in this article.

The Golden Ratio

A fascinating aspect of both quasi crystals and aperiodic mosaics is that the golden ratio of mathematics and art, the mathematical constant τ (tau), occurs over and over again. For instance, the ratio between the numbers of fat and thin rhombi in Penrose's mosaic is τ. The mathematical constant τ is described by a sequence of numbers that the 13th century Italian mathematician Fibonacci worked out from a hypothetical experiment. Both the Fibonacci sequence and the golden ratio are important to scientists when they want to use a diffraction pattern to describe quasi crystals at the atomic level. The Fibonacci sequence can also explain how the discovery awarded the Nobel Prize in Chemistry 2011 has altered chemists' conception of regularity in crystals.

Previously, chemists interpreted regularity in crystals as a periodic and repeating pattern. However, the Fibonacci sequence is also regular, even though it never repeats itself, because it follows a mathematical rule. The interatomic distances in a quasi crystal correlate with the Fibonacci sequence; atoms are patterned in an orderly manner, and chemists can predict what a quasi crystal looks like on the inside. However, this regularity is not the same as when a crystal is periodic.

In 1992, this realization led the International Union of Crystallography to alter its definition of what a crystal is. Previously a crystal had been defined as "a substance in which the constituent atoms, molecules, or ions are packed in a

regularly ordered, repeating three-dimensional pattern". The new definition became "any solid having an essentially discrete diffraction diagram". This definition is broader and allows for possible future discoveries of other kinds of crystals.

Quasi crystals: From Nature to Industry

Since their discovery in 1982, hundreds of quasi crystals have been synthesized in laboratories around the world. Not until the summer of 2009, however, did scientists first report naturally occurring quasi crystals. They discovered a new kind of mineral in samples taken in the Khatyrka River in Eastern Russia. The mineral in question consists of aluminum, copper and iron, and yields a diffraction pattern with tenfold symmetry. It is called icosahedrite, after the icosahedron, a geometrical solid with sides consisting of 20 regular three-cornered polygons and with the golden ratio integrated into its geometry.

Quasi crystals have also been found in one of the most durable kinds of steel in the world. When trying out different blends of metal, a Swedish company managed to create steel with many surprisingly good characteristics. Analyses of its atomic structure showed that it consists of two different phases: hard steel quasi crystals embedded in a softer kind of steel. The quasi crystals function as a kind of armor. This steel is now used in products such as razor blades and thin needles made specifically for eye surgery.

Despite being very hard, quasi crystals can fracture easily, like glass. Due to their unique atomic structure, they are also bad conductors of heat and electricity, and have non-stick surfaces. Their poor thermal transport properties may make them useful as so-called thermoelectric materials, which convert heat into electricity. The main purpose of developing such materials is to reuse waste heat, for example, from cars and trucks. Today, scientists also experiment with quasi crystals in surface coatings for frying pans, in components for energy-saving light-emitting diodes (LED), and for heat insulation in engines, among other things.

An Important Lesson for Science

Daniel Shechtman's story is by no means unique. Over and over again in the history of science, researchers have been forced to do battle with established "truths", which in hindsight have proven to be no more than mere assumptions. One of the fiercest critics of Daniel Shechtman and his quasi crystals was Linus Pauling, himself a Nobel Laureate on two occasions. This clearly shows that even our greatest scientists are not immune to getting stuck in convention. Keeping an open mind and daring to question established knowledge may in fact be a scientist's most important character traits.

***Courtesy*: Website of the Nobel Foundation.**

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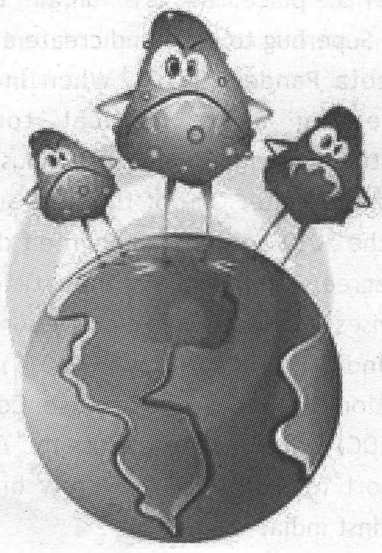
Metallo-Beta-Lactamase Responsible for Superbug – A Public Health Issue

Dr. Pradeep Kumar and Prof. Y. Hari Babu

Metallo-beta-lactamase is an enzyme which renders pathogenic bacteria resistance to a broad range of beta-lactam antibiotics. These include several antibiotic families, the principal ones being the Penicillins, Cephalosporins, Carbapenems and Monobactams (Balaram, 2010). Carbapenem family is a principle choice for the treatment of infections with antibiotic-resistant bacteria. An enzyme called beta-lactamase breaks the beta lactam ring of these antibiotics and nullifies the antibiotic's effectiveness. One of the examples of such enzymes is the NDM-1 (New Delhi Metallo-beta-lactamase), discovered in 2009.



The gene $bla_{NDM-1,}$ coding for NDM-1 enzyme, is one of the member of a large gene family encoding beta-lactamase enzymes called carbapenemases. There is a large amount of media hype on the word "Superbug" such that it has become a transcontinental public health issue. Currently, "Superbugs" are being referred to those bacteria that carry genes encoding for Metallo-beta-lactamase because these bacteria are resistant to almost all antibiotics that are available to treat the infections.

Metallo-beta-lactamase/carbapenemase

Metallo-beta-lactamases (MBLs) are zinc-dependent enzymes that have been the focus of increasing attention because of their ability to hydrolyze nearly all known beta-lactams and of the lack of clinically-useful inhibitors. Metallo-beta-lactamases are problematic due to:

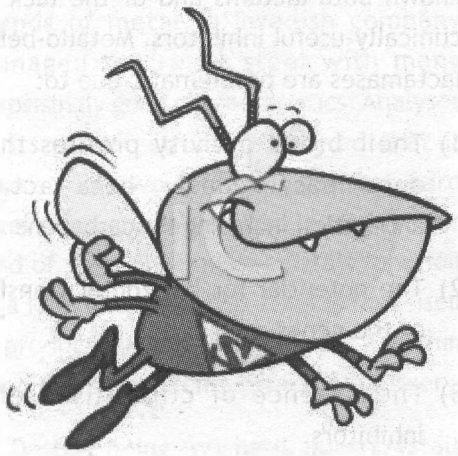
1) Their broad activity profiles that encompass most beta-lactam antibiotics, including the carbapenems,
2) The potential for horizontal transfer of the genes, and
3) The absence of clinically useful inhibitors.

In addition to beta-lactamases which cleave the amide bond of the beta-lactam ring, the metallo-beta-lactamase superfamily includes enzymes which hydrolyze thiol-ester, phosphodiester and sulfuric ester bonds as well.

The infections with such bacteria are very hard to treat successfully. Indeed, the United Kingdom Health Protection Agency has stated that "most isolates with NDM-1 enzyme are resistant to all standard intravenous antibiotics for treatment of severe infections."

The public health issue

There is a wide spread opinion that NDM-1 gene, originally described from New Delhi in December 2009, is now widespread in *Escherichia coli* and *Klebsiella pneumoniae* from India and Pakistan. It has become a topic of discussion in the news channels and press that NDM-1 carrying bacteria have been introduced to other countries (including the USA and UK), presumably by medical tourists undergoing surgery in India. It is a frightening picture and not supported by detailed scientific study.



In a study published in *The Lancet Infectious Diseases Journal* (Karthikeyan *et al.*, 2010), it has been said that NDM-1 was becoming more common in Bangladesh, India, and Pakistan and was also imported back to Britain in patients returning after treatment. The team which worked on this collected bacteria samples from hospital patients in two places in India, Chennai and Haryana, and from patients referred to Britain's National Reference Laboratory from 2007 to 2009. The team found 44 NDM-1-positive bacteria in Chennai, 26 in Haryana, 37 in Britain, and 73 in other sites in Bangladesh, India and Pakistan. It is wrong to quote isolated examples showing the presence of the organism in India when similar samples had been found in Israel, USA and Greece (Laura Donnelly, 2010).

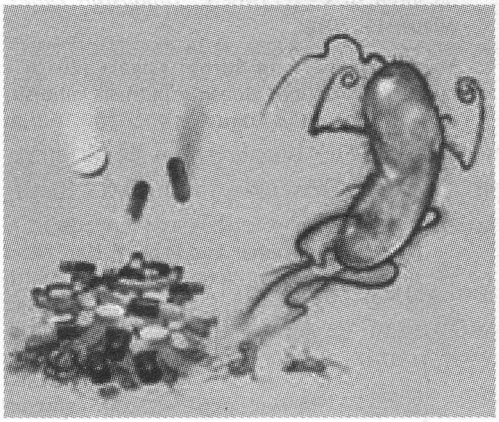
There should not be a debate over the issue of naming the enzyme New Delhi metallo-beta-lactamase-1. It isn't an unusual practice to name any new finding after the place. But it is "unfair" to link the Superbug to India and create a scare (Geeta Pandey, 2010). When India is emerging as a medical tourism destination, this type of malicious news is unfortunate. One of the lead authors of the 2010 *Lancet* study himself denied to agree with the part of the article that advises people to avoid elective surgeries in India (Pushpa Narayan, 2010). The National Centre for Disease Control (NCDC) which met to discuss the *Lancet* report termed it as "severely biased" against India.

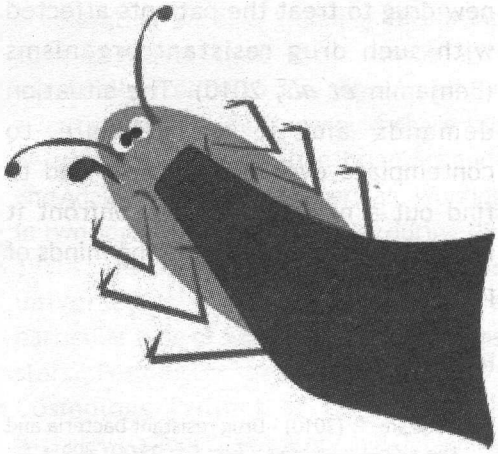
It has been published that, of the cases in Britain examined in the study, at least 17 of the patients had visited India and Pakistan in the last year. So the question comes about the rest of the patients. The investigators have to find out the past travel details of the remaining patients. The Indian Union Health Ministry official stated that many British patients who were positive for NDM-1 had no travel or connection to India (Sanchita Sharma, 2010).

A new article was published with the title "Superbug: 'Lancet doesn't publish rubbish, threat is real'" (Teena Thacker and Surbhi Khyati, 2010). It is agreed that this statement is true and it is true that the bacteria expressing the enzyme has been isolated from a patient who traveled India. But it doesn't mean that the bacterium isolated has evolved in India or is residing in India. It could have been acquired in any where on this world by the patient. It can be stated that they might have acquired the bacteria some where else. This is what has happened when Verona Integron encoded metallo-beta-lactamase 1 (VIM1) isolate. Initially it was isolated from the patient who traveled to Italy. But later when the places traveled by the patients were investigated the gene was traced in Greece, France, South Korea, Taiwan, Venezuela, Japan, Belgium etc. Therefore it is required to trace out the places traveled by those patients prior to coming to India.

And when deciding and declaring the place of origin of a bacteria isolated from a patient, other factors like incubation period of the agent also has to be considered. In May 2010, a case of infection with *E. coli* expressing NDM-1 was reported in the United Kingdom. And UK claimed that the patient was a man of Indian origin who had visited India 18 months back, where he had undergone dialysis. Here people have to put a thought, what this bacterium was doing for 18 months if it had been acquired in India?

Moreover, the fact that the "plasmid", associated with drug resistance to antibiotics, is present in the intestines of humans and animals universally, that keeps on mutating, has to be considered





before declaring the place of origin. The fact that bacteria can develop resistance to broad spectrum antibiotics is not new.

There are two challenges here. One is that a detailed epidemiological study is required all through the world to find the actual origin of this gene and to know the prevalence of bacteria with this gene in different parts of the world. The samples have to be collected from the hospitals and the people affected with the drug resistant bacteria from different countries of the world and tested for this gene. The people from whom the samples would be collected should be analysed for their past travel to different places in order to come to a definite conclusion.

Second is that, find out a new drug to tackle the problem instead of making it an issue and scaring the people. Mutation and development of drug resistance is an evolutionary process. It is an inevitable phenomenon. Then why so much scare? The scientists, investigators and the research and development component of pharmaceuticals and biotechnology firms should take it is a challenge to find out a new drug to treat the patients affected with such drug resistant organisms (Benjamin *et al.*, 2010). The situation demands and it is rationale to contemplate over this problem and to find out a new formula to confront it rather than creating fear in the minds of people.

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SCIENCE OF THE MONTH

N.S. Arun Kumar

OCTOBER 2011

October 1: The Bangalore-based Ganit Lab sequenced and analyzed the genome and coding parts of the Neem plant. Neem tree and its parts have been used since time immemorial in the country and its insecticidal, pesticidal, fungicidal and medicinal properties are well known. Understanding the molecular architecutre of the Neem genome and its various coding parts will enhance the knowledge about this wonder species further. Ganit Labs is currently building an open access portal to host information gathered from the current study on genome, genome architecture, coding parts and molecular evolution of the Neem plant. In addition to Neem, Ganit Labs has sequenced 'tongue cancer genomes' from Indian patients. Karnataka Government's IT and BT Department is funding Ganit Labs, a non profitorganisation.Link: http://www.ganitlabs.in

October 2: This year's Ig Nobel prizes were annouced last night in a ceremony at Harvard University. The biology prize was given to a team or researchers for discovering that certain types of beetles try to mate with particular types of short, dark beer bottles in Australia which they confuse for female beetles. Japanese researchers have applied for a patent for an odor-generation alarm based on the pungent sushi condiment. Wasabi received the Chemistry Prize. Other winners had research looking at why we sigh, whether yawning is contagious in the Red-Footed Tortoise etc. Presented by the *Annals of Improbable Research* Magazine the Ig Nobel Prize awards are famous for *"first making people laugh, and then make them think".* Link: http://improbable.com

October 3: Three scientists shared this year's Nobel prize for medicine. Bruce Beutler of the US, Jules Hoffmann from France and Ralph Steinman from Canada all shared the prize. Profs. Beutler and Hoffman discovered how the body's first line of defence was activated. In 1996, Prof. Hoffmann discovered that a gene called "Toll" was essential for kick starting the innate system in fruit flies. Without the gene, the flies could not "sense" and then fight bacterial infection. An equivalent gene, Toll-like receptor, was found by Prof. Beutler in 1998 in his study on mice. Prof. Steinman discovered the dendritic cell, which helps defeat infection. He showed that it can act as a bridge between the two immune systems, deciding whether to activate the adaptive system or not. Link: http://www.nobelprize.org

October 4: Three U.S.-born scientists won the Nobel Prize in Physics for discovering that the universe is expanding at an accelerating pace, a stunning revelation that suggests that the cosmos will eventually freeze to ice. The American scientist Saul Perlmutter would share the award with U.S.-Australian Brian Schmidt and Adam Riess, another American. Working in two separate research teams during the 1990s, the scientists raced to map the universe's expansion by analyzing a particular type of supernovas, or exploding stars. Perlmutter, heads the Supernova Cosmology Project at the Lawrence Berkeley National Laboratory and University

of California, Berkeley. Schmidt, is the Head of the High-z Supernova Search Team at the Australian National University in Weston Creek, Australia. Riess is an Astronomy Professor at Johns Hopkins University and Space Telescope Science Institute in Baltimore, Maryland. Link: http://www.nobelprize.org

October 5: Israeli scientist Daniel Shechtman won this year's Nobel Prize in Chemistry for discovering a material in which atoms were packed together in a well-defined pattern that never repeats. Shechtman, 70, a Professor of Materials Science at Technion - Israel Institute of Technology won the prize "for the discovery of quasi crystals." Dr. Shechtman had to fight a fierce battle against established science to convince others of what he had first seen in his lab at the National Institute of Standards and Technology in Washington - formerly called the National Bureau of Standards - on an April morning in 1982. Dr. Shechtman himself is said to have cried "*Eynchayakazo*", which translates from the Hebrew as "there can be no such creature". Link: http://www.nobelprize.org

October 6: India government has unveiled the National Frequency Allocation Plan-2011 (NAFP) which is a policy document that contains spectrum allocation to various radio communication services and applications in different frequency bands.Some of the features of NFAP-2011 are that it is in line with the radio regulations of International Telecommunication Union (ITU).To be effective from October 1, the NFAP-2011 contains spectrum allocation for various radio communication services and applications in different frequency bands. The NFAP Policy has reserved spectrum in 900 MHz, 1400 MHz and 1800 MHz bands for promoting indigenous manufacturing in the country. Link: http://www.dot.gov.in

October 7: Craig Venter, the pioneering scientist who created the world's first synthetic cells received the Dickson Prize in Medicine – the most prestigious honor granted by the University of Pittsburgh School of Medicine.The award, presented annually to a leading American biomedical researcher, came on the opening day of Pitt's Science 2011 showcase, which concludes today. In February 2001, Venter published the first completely mapped human genome. His most recent achievement, announced in 2010, involved using a computer code to artificially reproduce in a laboratory the DNA of the world's smallest bacteria. Venter heads the J. Craig Venter Institute, a non-profit research facility in Rockville, Va., and two companies, Synthetic Genomics and Synthetic Genomics Vaccines.Link: http://www.jcvi.org

October 8: ESA's *Venus Express* spacecraft orbiting Venus has discovered an ozone layer high in the planet's atmosphere, similar to that surrounding Earth and Mars according to astronomers. The study was recently presented at the Joint Meeting of the European Planetary Science Congress and the American Astronomical Society's Division for Planetary Sciences. While observing stars visible right at the edge of the planet, set through its atmosphere, ESA's Venus Express spacecraft made the discovery. Ozone has also been regarded as a potential biomarker, since it traces the distribution of molecular oxygen. Ozone was found previously only in the atmospheres of Earth and Mars. Link: http://www.esa.int

October 9: Top sea turtle experts from around the globe have discovered that almost half (45 percent) of the world's threatened sea turtle populations are found in the northern Indian Ocean, specifically threatened populations of both Loggerhead Turtles (*Caretta caretta*) and Olive Ridley

Turtles (*Lepidochelys olivacea*). The study also highlighted the 12 healthiest sea turtle populations in the world, such as the Hawksbill Turtle (*Eretmochelys imbricata*) and the Green Turtle (*Cheloni amydas*).The recent report, produced by International Union for Conservation of Nature's Marine Turtle Specialist Group and supported by Conservation International and the National Fish and Wildlife Foundation, is the first comprehensive status assessment of all sea turtle populations globally. Link: http://iucn-mtsg.org

October 10: A team of researchers trawling the ocean floor have just published their findings of the world's new largest virus, found lurking off the coast of Las Cruces, Chile. The virus with the scientific name *Megaviruschilensis* can even be viewed with a basic light microscope. The previous virus record holder was Mimivirus, which boasted the largest diameter of any virus to date. The Megavirus' DNA features 1,259,197 base pairs, which encode some parasitic bacteria-like features. Mimivirus was found in 1992, lurking in an amoeba in Bradford, England. Most viruses fall in the range between 20 and 300 nanometres, making both Mimivirus and the new Megavirus titans of the microscopic world. Link: http://www.giantvirus.org

October 11: If you're a student between the ages of 14-18, you are eligible to enter a new contest announced this week, called Space Lab. The competition, sponsored by YouTube and Lenovo, gives students the opportunity to submit a science experiment that will be conducted at the International Space Station and streamed live to Earth *via.* YouTube. Additionally, the winner will have the choice of watching live as his experiment launches into space from Japan or waiting until she turns 18 and receiving cosmonaut training in Star City, Russia. Entries can be submitted as a team or as an individual and must be submitted in video format, with a running time of less than 2 minutes. But don't delay - all entries must be received by December 7. So put on your thinking cap, fire up your video camera, and come up with a great experiment. Link: http://www.youtube.com/user/spacelab

October 12: India took a niche position alongside France in an exciting area of climate research, as the Indian Space Research Organisation (ISRO)'s Polar Satellite Launch Vehicle (PSLV-C18) on today successfully launched a unique science satellite called Megha-Tropiques from the first launch pad at the Satish Dhawan Space Centre. Nearly 26 minutes after the lift-off, Jugnu, SRMSat and VesselSat-1 separated. Megha-Tropiques carries four instruments that include MADRAS (Scanning Microwave Imager for Detection of Rain and Atmospheric Structures) developed jointly by the ISRO and CNES, and "Radio Occultation Sensor for Vertical Profiling of Temperature and Humidity," which was received from Italy. Link: http://meghatropiques.ipsl.polytechnique.fr

October 13: An international team of scientists has sequenced the entire genome of a varient of the Plague bacterium (*Yersinia pestis*), extracted from skeletons more than 700 years old. It's the first time scientists have been able to draft a reconstructed genome of any pathogen older than 100 years or so, and could lead to a better understanding of modern infectious diseases. The team found that a specific variant of the *Yersinia pestis* bacterium was responsible for the plague that killed 50 million Europeans between 1347 and 1351.The team analyzed skeletal remains from victims buried in the East Smithfield plague pits in London, located under what is now the Royal Mint.The direct

descendants of the Smithfield bubonic plague still exists, however, killing 2,000 people each year. Link: http://www.nature.com

October 14: The high peaks of the Himalayas may soon be a beacon for adventurous solar power entrepreneurs, suggests a new study. Other regions not traditionally considered hotbeds of solar power potential include the Andes of South America and Antarctica, note Takashi Oozeki and Yutaka Genchi with the National Institute of Industrial Science and Technology in Japan. In addition to copious amounts of sunlight, these regions are chillier than the usual suspects such as the southwestern United States and the deserts of North Africa. Colder temperatures increase the operational efficiency of certain photovoltaic solar cells, which turn sunlight into electricity. The finding is based on a global analysis of photovoltaic potential that takes into account the effect of ambient temperature, something the team says has not been done before. Link: http://www.aist.go.jp

October 15: Bristol University students, both past and present, are behind the most popular student-run online news magazine in the country. Erudition began as a print publication but has evolved into a collection of three magazine-style websites, each covering the broad topics of the economy, politics, science, engineering, arts and culture. The latest addition to the online series is Experimentation, which covers the latest news and views on the world of science and engineering. It has just been launched by Editor-in-Chief Alistair Jacklin, who has worked hard with his news team over the last six months to create the website. The websites, which are updated with new editions each month, actively promote debate through its news and in-depth features. Link: http://www.eruditiononline.co.uk

October 16: The contest begins for the new name for New Mexico's world famous radio telescope facilities. This telescope seeks a new name after completing extensive upgrades, which started in 2001. They are looking for a creative name that reflects the VLA's future role in astronomy, while still honoring its past achievements of success. The National Radio Astronomy Observatory (NRAO) wants to open up the choice to the public's creativity. The contest is open until 1 December and the winner will be announced at the American Astronomical Society conference in January. The search for a new name comes after the radio telescope underwent an expansion of upgrades. Officials say the VLA's original, 1970s electronics have been replaced with state-of-the-art equipment. Link: http://www.nrao.edu/namethearray

October 17: The Soviet-era work-horse, Soyuz rocket will be launched from Europe's space base in South America. It will be the first time that the legendary rocket, which traces its lineage to Sputnik and Gagarin, has been deployed outside Russia's bases. And its payload will be the first two operational satellites in Galileo, Europe's •5.4bn rival to the US Global Positioning System (GPS). Soyuz is the world's most successful rocket, with a whopping 1776 launches under its belt if the count includes forerunners dating back to 1957. Until now, Soyuz has been launched from Plesetsk, in northern Russia, or from Baikonur, in Kazakhstan. Under a 2003 deal, Russia agreed to launch it from ESA's base in Kourou, FrenchGuiana. Link:http://www.esa.int

October 18: Researchers have sequenced the genome of a Dutch woman who held the title of the world's oldest person when

she died, aged 115. The study of Hendrikje van Andel-Schipper, could help to understand the biology of ageing, scientists say. A team led by HenneHolstege, of the VU University Medical Center in Amsterdam, has begun to compare DNA from van Andel-Schipper's blood and brain, to determine how different genetic mutations arise in these tissues. The genome will provide researchers with an unprecedented resource for investigating how DNA contributes to longevity and diseases of old age such as Alzheimer's. Van Andel-Schipper died of gastric cancer, having survived breast cancer at the age of 100. Link: http://www.vumc.com

October 19: The documentary produced by Indian Institute of Science Education and Research (IISER), *Chandra: In Quest of Perspectives*, on the life and works of the astrophysicist Subramanyam Chandrasekhar will be aired on Doordarshan today at 9.30 am. His work showed that a star higher than the so called "Chandrasekhar Limit" (mass 1.44 times that of the sun) will continue to collapse beyond what is called the White Dwarf to become a Neutron star or a Black hole following a supernova explosion. The documentary, an initiative to popularise science, is part of the centenary celebrations highlighting Prof S. Chandrasekhar's contribution to physics and mathematics in general and astrophysics in particular. Link: http://www.iiserpune.ac.in

October 20: Stem cell scientist Hwang Woo-suk at the Sooam Biotech Research Foundation released eight Coyotes also known as the American jackal or the Prairie Wolf (*Canis latrans*) that he and his research team claimed to have cloned in Pyeongtaek, Gyeonggi Province. The Coyotes will be donated to a wildlife center. With this Hwang has become the world's first to clone Coyotes. Amother news said that *Royal Blue Boon*, the Quarter Horse mare which was the first commercially cloned horse, died last week in Texas, at the age of 31. The Quarter Horse mare was one of the leading producers of cutting horses in recent years. The clone -the filly *Royal Blueboon Too*- still resides on Hall's farm. Link: http://www.allbreedpedigree.com

October 21: 2011 New data released by NASA and NOAA show in September the Ozone hole over Antarctica was the 9th largest on record - stretching over 16.17 million square kilometers. On the southern hemisphere the story seems much the same. Earlier this month over Antarctica the 10th lowest ozone concentration was measured: 102 Dobson units. CFC-induced ozone breakdown requires extremely low stratospheric temperatures and sunlight. That's why the ozone layer depletes more just after winter, when temperatures 10 kilometers up in the sky can be low enough for polar stratospheric ice clouds to form, and the onset of spring adds a little UV radiation to get the catalytic breakdown reaction going. Link: http://www.wmo.int

October 22: Fresh from the successful launch of *Megha Tropiques* satellite on October 12, India and France today eyed another milestone of a new satellite dedicated to environment monitoring. The forthcoming launch of SARAL, a joint satellite to study sea surface altitude would be another milestone in space cooperation. SARAL would help ocean scientists gather accurate data on the rise in the sea level which could threaten the low lying and coastal areas of the country. The joint statement by Indian Space Research Organization (ISRO) and the French National Space Agency (CNES) will be pursuing the cooperation further within the framework of a memorandum of understanding signed in December last year. Link: http://www.isro.org

October 23: The 21-year-old German Roentgen Satellite, or ROSAT, re-entered Earth's atmosphere over the Bay of Bengal today. It is not known whether any debris reached Earth's surface. Damage to property caused by ROSAT has not been reported. Engineers expected that 1.7 tons of debris from the X-ray astronomy satellite would survive re-entry and reach the surface, creating a 1-in-2,000 chance that someone would be injured by it. NASA's Upper Atmosphere Research Satellite, or UARS, re-entered the atmosphere on September 24 and plunged into the Pacific Ocean, well away from the North American coastline. The 6.5-ton UARS spacecraft was the largest NASA satellite to fall uncontrolled from orbit since 1979.

October 24: China would next month launch its much-awaited Mars probe mission, entering further deep into space exploration following two lunar projects, as the country braces itself for a deep space competition with the US. China's first Mars probe will be launched between November 8 and 20, after two years delay, a top scientist said. *Yinghuo-1*, a micro-satellite weighing 110 kg, will be sent into space with Russia's *Phobos-Grunt* mission at the Baikonur Cosmodrome launch site in Kazakhstan. The probe is expected to enter a preset orbit around Mars between August-September next year. Last month China successfully launched its maiden space lab *Tiangong-1*. Link: http://www.cnsa.gov.cn

October 25: In context of World Polio Day today, Government of India declared that only one polio case has been detected so far this year in the country making it the longest polio-free period ever since eradication efforts were launched. The only case of polio reported this year has been from Howrah district in West Bengal on 13th January 2011 as compared to 39 cases in the country in the same period of 2010. For the first time no case of polio has been reported from UP (since April 2010) and also from Bihar (since September 2010). No case of Type 3 polio has come up for over a year. Closest ever to eradicating polio, Government of India has decided to treat any fresh case of polio as a 'public health emergency'. Link: http://www.worldpolioday.com

October 26: An international team of scientists led by Dr. Aaron Jex from The University of Melbourne have sequenced the genome of the common roundworm (*Ascaris suum*). The team hope the genetic roadmap of the giant worm, which infects pigs, can lead to the development of treatments for both animals and humans. It is a very close relative and excellent model for a really important parasite in humans which is *Ascarislumbricoides*. While *Ascaris suum* causes major losses in the pig industry, *Ascaris lumbricoides* causes a disease called Ascariasis, which kills around 135,000 people - mainly children - each year in developing regions of South EastAsia, China, South America and Africa. Their results appear in today's issue of *Nature*. Link: http://www.nature.com

October 27: Bangladesh, India and the Democratic Republic of Congo (DRC) are among 30 countries with "extreme" exposure to climate shift, according to a ranking of 193 nations by *Maplecroft*, a British firm specializing in risk analysis. Five Southeast Asian nations - Indonesia , Myanmar, Vietnam, the Philippines and Cambodia - are also in the highest category, partly because of the rising seas and increasing severe tropical storms. Maplecroft's tool, the Climate Change Vulnerability Index (CCVI), looks at exposure to extreme weather events such as drought,

cyclones, wildfires and storm surges, which translate into water stress, loss of crops and land lost to the sea. Of 30 nations identified in the new report as at "extreme" risk from climate change, two-thirds are in Africa and all are developing countries. Link: http://maplecroft.com

October 28: A team of researchers including from the Zoological Survey of India, Western Ghat Regional Centre, Kozhikode has discovered a new species of limbless amphibian from Western Ghats. The new species, *Ichthyophis davidi*, a yellow striped caecilian was discovered from the Belgaum district of Karnataka, which is part of the Western Ghat. *Ichthyophis davidi* is one of the largest known yellow striped caecilians from Western Ghats and is named in honour of David Gower, Department of Zoology, The Natural History Museum, London, in recognition of his contributions to Indian caecilian studies. The members of the genus *Ichthyophis* include both striped and non-striped caecilians. The discovery has been published in the latest issue of *Current Science*. Link: http://cs-test.ias.ac.in

October 29: Indian scientists have mapped the genome of a Sri Lankan individual. The project involved the Centre for Genomic Application, a public-private company floated by the Council of Scientific and Industrial Research (CSIR) and Kolkata-based Institute of Molecular Medicine. Sridhar Sivasubbu, a CSIR researcher involved with the Sri Lankan genome-mapping exercise, said that though the mapping project was a commercial deal, it involved Indian scientists "sharing knowledge" with Sri Lankan collaborators. India was now a $25 million market for genome sequencing applications. Though the Sri Lankan genome was mapped in December, it is yet to be formally announced *via.* a scientific publication. Link: http://www.tcgaresearch.org

October 30: On November 8, an asteroid 400 meters across will pass by us, missing the Earth by the very comfortable margin of about 320,000 kilometers. Named *2005 YU55*, it is one among those called *Potentially Hazardous Asteroid* because its orbit intersects that of Earth. But observations have shown that it won't be a danger to Earth for at least a century, and probably much more, eventhough astronomers world over will be observing it carefully, as it is a very closer pass by. There are plans to use NASA's Deep Space Network of radio telescopes, as well as the Arecibo 'scope in Puerto Rico (which was used to make the image above back in April 2010) for observing it. Link: http://deepspace.jpl.nasa.gov

October 31: In the wake of September's surprising experimental results that suggested the observation of faster-than-light neutrinos, CERN has announced that it has been re-running the experiment over recent days. Criticisms of the experiment have proposed errors in the time measurement, or have asked whether CERN properly accounted for Earth's rotation, or queried the statistical analysis of the results. The old experimental design, which used 10 microsecond bursts of protons at CERN to generate the neutrinos, is being replaced by a new design in which the proton bursts will last just a couple of nanoseconds, with a 500 ns gap between bursts. This should permit a more precise calculation, scientists think. Link: http://public.web.cern.ch

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SCIENCE INDIA QUIZ

Send the correct answers to Science India office or to arsmenon@gmail.com/scienceindia2010@gmail.com latest by 20th December, 2011. A science book as prize awaits you. If there are more than one correct entries, the winner will be selected by draw of lots

- Editor

SCIENCE INDIA QUIZ NO. 25

1. Sound waves having frequency higher than audio frequency range.
2. The allotropic form of phosphorus used in match industry is -------
3. According to zoological classification of the animal kingdom, man belongs to the class of -------
4. The main constituent of haemoglobin
5. Cooking gas is a mixture of -------
6. Lock Jaw, i.e., difficulty in opening the mouth is a symptom of -------
7. The approximate circumference of the earth is -------
8. Gland that keeps the balance of water and salt in human body
9. Scientist who suggested the presence of carbohydrates in the plasma membrane in 1962
10. Science of skin patterns

Answers to Quiz No. 24

1. Centripetal force 2. Phosphorus 3. Porifera 4. Calcium phosphate 5. Sulphuric acid 6. Heart 7. Venus 8. Ada Lovelace 9. Beaver 10. Density

The winner is Kum Maya Menon, Chinmaya Vidyalaya, Poothole, Thrissur CONGRATULATIONS !!!

SWASRAYA BHARAT 2011

3. Students' Congress

3.1 Students' congregation and interaction

Thousands of students from different parts of the state congregating at the pavilion is a note-worthy feature of *Swasraya Bharat*. The main objective is to provide the students an opportunity to interact with the most eminent personalities of our country so as to inspire the youth and become active partners in the self-reliance process.

3.2 The pledge of Self-Reliance

The programs will encompass a vast gathering of students from the different schools of Kerala at a single pavilion to take the pledge of Self-Reliance under the tutelage of an educationalist of national caliber.

A booklet containing the information on the achievements of Indian science and technology will be distributed to lakhs of students all over Kerala during the National Self Reliance celebrations.

3.3 Students' competition

Quiz, essay and painting competitions on India's glorious scientific traditions and to instill the spirit of self reliance will be held at State level for school students.

4. Environmental Congress

The concept of the environment and its preservation had prevailed in India centuries back. Ancient Texts of India had warned that " So long the rivers like Ganges had pure and drinkable water, so long the only energy source the Sun, shines through an un-polluted sky, so long the mountains like Meru have forests and minerals, that long you, men would live along with your brethren and relatives having being fed by the fertile Mother Earth." This concept will be emphasized in the Environmental congress. Environmental congress consists of project competition for students and students' interaction with a prominent environmental scientist.

5. Traditional Health Practitioners' Congress

The nature provides positive health to human beings and is the greatest immunizing agent for preserving health at optimum level. Nature cure is in tune with the laws of nature and hence adverse effects do not arise. The expertise gained by the SSM by way of organizing World Ayurveda Congress, handling health Projects and interactions with the tribals at Wayanad, Idukki and Attappadi will be put to use in organizing the Traditional Health Practitioners Meet at the Swasraya Bharat 2011. Seminar on Traditional Medicine consist of Paper Presentation and Medical consultation camp.

6. Cultural Programs

An individual blossoms when he or she is wedded to arts. This is a saying and its truth has been upheld for long. The cultural programs have been planned with this aspect in mind.

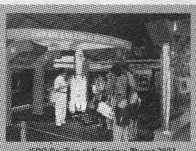
SWADESHI SCIENCE MOVEMENT, KERALA

Swadeshi Science Movement [Kerala chapter of Vijnana Bharati] is a leading science movement at national level. It is essentially a Science Movement with the motto 'Science and Technology for Social Harmony' embodied with the national spirit aiming to bring about national renaissance and reconstruction. It is a popular science movement, which aims at the development and propagation of science at all levels, right from popular to professional and research. Swadeshi Science Movement aims at fostering multi-disciplinary approach to solve the local problems and promotion of India's Scientific Heritage. Thousands of Scientists and Academicians, and Public are involved in the successful implementation of the activities of SSM.

Swadeshi Science Movement has been bestowed with the prestigious "National Award for Outstanding Efforts in Science and Technology Communication" for the year 2006 by Ministry of Science and Technology. The Award was presented by Shri Kapil Sibal, Hon'ble Minister for Science and Technology, Govt. of India on 1st March 2007 at New Delhi. This Award was conferred to the Swadeshi Science Movement for its relentless work in the field of science and technology communication over the past two decades.

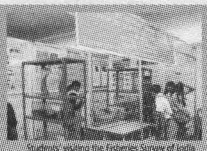
Swadeshi Science Movement is also the winner of Jawaharlal Nehru Prize for 2005-06 by the Govt. of India and ISCA and the award was presented by the Hon'ble Prime Minister of India, Dr. Manmohan Singh on 3rd January 2006 at the inauguration of 93rd Indian Science Congress held at Hyderabad. SSM strives to achieve overall excellence in science, engineering and technology at the national, regional and grass-root levels. The Movement works to evolve a policy directed towards the up-gradation of swadeshi science thereby enabling India to assert herself in the field of modern science and technology.

Dr. Sibaji Raha, Director, Bose Institute addressing the students' gathering during Swasraya Bharat 2010

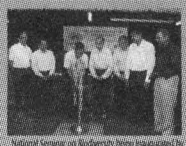


ISRO Pavilion at Swasraya Bharat 2007

Dr.R.Chidambharan,Principal Scientific Advisor, Govt of India visiting the DRDO pavilion during Swasraya Bharat 2007



Students' visiting the Fisheries Survey of India Pavilion during Swasraya Bharat 2010



National seminar on Biodiversity being inaugurated by Dr. Ramachandran Thekkedathu, Dr. Varma, Dr. N G K Pillai, Dr. K. Ravindran, Dr.A. Ramachandran are also seen

SWASRAYA BHARAT 2011

KOCHI 2011

SWASRAYA BHARAT 2011

15th - 20th December, 2011

Shiva Temple Ground, Kochi, Kerala

Bharat, a multi-lingual, multi-ethnic and multi-religious nation has been the source of inspiration for humanity and provided a milieu for the full expression of human creativity and ingenuity. History tells us that for ages Bharat has been regarded as the "Preceptor of the Universe". True to this, the legacy of 'Krinvanto Vishvam Aryam' – we shall make the entire world excellent, 'Vasudhaiva Kutumbakam' - the entire world is one large family, was in transmission for generations. As embodied in these ancient ever relevant words of wisdom, we realize that, to fulfill our global responsibilities, it is inevitable for our country to achieve prosperity in all areas of thought and action.

We conceive of the modernization and economic development of a nation as a continuous process involving the transformation of traditional institutions and technology by the application of modern scientific knowledge. A nation can effectively adopt modern science and technology for the purposes of development without losing it's identity. We also understand fully that only through the path of Self Reliance, built up on indigenous values and individual talent, India can achieve sustainable progress in the modern world of intense competition. We can achieve this goal only through hard and gargantuan joint efforts of the society as a whole.

SWASRAYA BHARAT - The Prime Mover for motivation

'Swasraya Bharat' is a unique concept which means "Self Reliant India". This gigantic effort essentially demands massive mobilization and motivation of the entire society, comprising of students, teachers, youth, scientists, technocrats, academicians and the public at large, in this national endeavor for promotion of self-reliance. The resultant pool of talents bursting with intellectual energy built on indomitable national spirit, confidence and courage will be significant factor triggering the morale of our citizens towards National Renaissance, Reconstruction and Self Reliance. India is on a great march of rejuvenation and revitalization and Swasraya Bharat is an effort to catalyse the same.

PROGRAM AT A GLANCE

1. VigyanMela: Scienceand Technology Expo

A 6-day Mega Science and Technology Expo under the name, Vigyan Mela is a major event of Swasraya Bharat 2011. Swasraya Bharat had been conducted successively for the past six years. The Expo will showcase India's remarkable achievements in frontier areas of science, technology, engineering and a host of other fields in which India has undisputed leadership.

It will be an exposition of innovations depicting the enormous capabilities of India from the ancient past to the 21st century. Further, the event provides a vibrant platform for interactions with the Industry, Research Institution, academic fraternity and young researchers. Participants from Space Commission, CSIR, ICAR, DRDO, DST, ISRO, DAE,CIAL, Universities, Corporate sectors, IT sector and other establishments of our country will provide a scintillating experience. The achievements of Indian financial organisations and rural sectors will also be highlighted.

The S &T expo will consist of the following pavilions:

- Science and Technology
- Biodiversity
- Energy
- Space and Defence
- Agriculture
- Traditional Medicine
- Aquashow
- Fisheries
- Schools' Pavilion

Our previous experience is that tens of thousands of Students, Teachers, Scientists and General Public have visited the Expo in the previous years and we are confident that the same patronage will be forthcoming in this expo also. The visitors will have an opportunity for closer look at the technological supremacy of our country which will certainly make them proud and inspire them to work towards National Self Reliance.

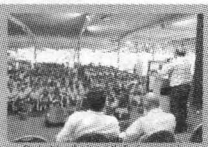
2. National Seminars on

- Greening the Forests for a Safe living
- Green Chemistry for Green Future
- Self Reliance in Space and Defence
- Harmful Algal Blooms on Marine Eco-System

His Excellency R.L.Bhatia, The Governer of Kerala inaugurating PRITHVI-2005 Global Eco Meet

Dr.R.Chidambaram,Principal Scientific Advisor,Govt.of India,inaugurating Swasraya Bharat 2007

Dr. A.P.J Abdul Kalam addressing the gathering at Igniting the Aspirations, Kochi



Students' gathering at theEnvironmental Congress during Swasraya Bharat 2009

Dr. D. Sivakaran, Former Director NPOL, Kochi inaugurating the National Seminar during Swasraya Bharat 2005

Swadeshi Science Movement, Kerala

ACTIVITIES

- Swasraya Bharat (National Self-Reliance Celebrations).
- Swadeshi Science Congress.
- Aryabhateeyam (National Seminar on selected themes).
- Sastra Pratibha Matsaram (Science talent search examination for students).
- National Science Day Celebrations.
- National Technology Day Celebrations.
- National self-reliance Day Celebration.
- Face to face (Student interaction with scientists).
- Sastra madhanam (Brain storming in selected topics in Ayurveda).
- Ashtangahridaya Satram (Deliberations with Acharyas on Ashtangahriyadya).
- Environmental Day Celebrations.
- Publication of Science India (National Science Magazine).

PROGRAMMES

- Science Communication Workshops.
- Workshops on Science Communication through Cultural /Folk / Digital Media.
- Workshops on Science Journalism.
- Science and Technology Entrepreneurship Development Project.
- Nature Activity Camps.
- Ayurveda Medical Camps.
- Awareness Programs on Contemporary Issues.
- Science Lecture Series.
- World Ayurveda Congress.
- Prithvi (Global Eco - Meet).
- Nadeevandanam (Movement for River Protection).
- Prakriti Vandana Yatra (Movement for Nature Protection).

SARANIES

- Vagbhada Sarani (Faculty of Ayurveda).
- Ramanuja Sarani (Faculty of Mathematics).
- Bharadwaja Sarani (Faculty of Engineering).
- Vastuvidya Sarani (Faculty of Architecture).
- Yoga Vidya Sarani (Faculty of Yoga).
- Parasara Sarani (Faculty of Agriculture).
- Thyagaraja Sarani (Faculty of Music).
- Swedeshi Science Research Institute (SSRI).
- Green Doctors (A Movement for Socio-Environ action).
- Nalanda Virtual University .
- Shakti (Women's Wing).
- Publication Division.

SWASRAYA BHARAT 2011

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Prof. V.P.N. Nampoori (State Secretary) receiving "National Award for oustanding efforts in Science and Technology" from Shri. Kapil Sibal, Hon'ble Union Minister for Science & Technology,

Shri. P.N. Subramanian (State President) receiving 'Jawaharlal Nehru Prize' for Science Popularisation from Hon'ble Prime Minister Dr. Manmohan Singh

Shri. Tony Chamminy, Mayor, Kochi Corporation Inaugurating the Science and Technology expo of Swasraya Bharat- 2010 at Kochi.

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स्वस्रय भारत

KOCHI 2011

SWASRAYA BHARAT 2011

15th - 20th December, 2011

Shiva Temple Ground, Kochi, Kerala

- Science and Technology Expo
- National Seminars
- Environmental Congress
- Students' Congress
- Traditional Health Practitioners' Congress
- Students' Competition

SWADESHI SCIENCE MOVEMENT, KERALA

(A unit of Vijnana Bharati)

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